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REEVALUATION OF THE GENUS PHYLLOPSORA WITH TAXONOMIC NOTES AND INTRODUCTION OF SQUAMACIDIA, GEN. NOV.

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SUMMARY

A new delimitation of Phyllopsora Müll. Arg. is presented based on study of all available type specimens of this genus and comparison with type material of related genera. Over 2000 general collections were examined, including abundant new material collected by the author and others in the neotropics. As a result of these studies, several taxa are excluded from Phyllopsora to allow for a more natural generic concept. This paper provides appropriate taxonomic and nomenclatural changes in Phyllopsora and introduces a new genus, Squamacidia, in anticipation of a forthcoming full monographic treatment of Phyllopsora.

INTRODUCTION

Müller-Argau (1894) first described the tribe Phyllopsorae in his systematic survey of New Zealand lichens, including it in his "Series II Thamno-Phylloblastae." He differentiated it by a loosely or moderately fixed squamulose thallus, "gonidia palmellaceae" and biatorine-lecideine apothecia. He included two genera in this tribe, distinguishing Phyllopsora by simple hyaline spores, and Psorella by transversely septate, hyaline spores. He assigned four species, one of which was regarded as doubtful, and one variety, to Phyllopsora. Zahlbruckner (1903-1908, 1926-1927) presented Müller-Argau's tribe as the family Phyllopsoraceae, including 41 species with numerous varieties in Phyllopsora and 14 species and one variety in Psorella, but he did not elaborate on Müller-Argau's original differentiation of these genera.

Currently, there are over 90 published names in Phyllopsora. The genus has not previously been monographed. Swinscow & Krog (1981) provided a detailed account of the eleven East African species, with notes on additional material they examined, including most of the type specimens. Phyllopsora was delimited by Swinscow & Krog (1981) and Hafellner (1984) by the following characters: 1) a squamulose thallus with an obvious prothallus, 2) an ascal apex composed of a hyaline hemispheric dome staining blue with iodine and surrounding a narrow, conical, lighter-staining masse axiale, 3) paraphyses with colorless unswollen apices, and 4) biatorine apothecia with a hypothecium composed of highly gelatinized hyphae. Swinscow & Krog (1981, 1985) briefly discussed the problem of distinguishing Phyllopsora from Bacidia De. Not. One of the main problems in understanding Phyllopsora is that in addition to Bacidia, several genera such as Biatora Th. Fr., Eschatogonia Trevisan, Psorella Müll. Arg. and Physcidia Tuck., include species that share many characters with Phyllopsora. In the past, these genera have been separated primarily by vegetative characters, but most of the taxa of these genera have not been critically examined since their original description.

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Reexamination of type material and study of general collections of Phyllopsora and related genera (Brako, 1987) have provided information for the following generic delimitation of Phyllopsora and comparison with other genera.

TAXONOMIC SECTION

Phyllopsora Müll. Arg.
Bull. Herb. Boissier 2 (Appendix 1): 11. 1894.
Type species: Phyllopsora breviuscula (Nyl.) Müll. Arg. (This agrees with the lectotype designated by Clements & Shear, The Genera of Fungi, p. 319, 1931).

Thallus squamulose, small foliose, rarely appearing crustose. Squamules 0.1-1.0 mm wide. Upper surface glabrous to rough, fibrillose at the margin. Isidia common, sometimes dominating the thallus. Upper cortex 10-60 µm thick, consisting of anticlinally oriented, thin- to thick-walled hyphae with round to narrowly cylindrical lumina, commonly containing lichen substances. Photobiont in a continuous layer, green, unicellular, 5-15 µm diam., genus where known Pseudochlorella. Medulla usually poorly developed, of loosely woven and nonamyloid hyphae, frequently containing lichen substances. Lower cortex absent. Prothallus pale to dark red. Lichen substances: argopsin, atranorin, norargopsin, norvicanicin, pannarin, vicanicin, zeorin and numerous unknown compounds.

Apothecia to 1.5 mm diam., simple or aggregated, attached laminally to the squamules. Disc plane to convex, margin often slightly raised, tan to dark reddish-brown, epruinose. Exciple composed of radiating hyphae, tan to golden-brown or dark red, sometimes containing crystals. Hypothecium tan to golden-brown, or dark red, sometimes containing crystals, KOH- or KOH+ scarlet or purplish-red. Hymenium 20-60 µm tall, amyloid, epihymenium indistinct or a thin gelatinous layer with slight pigmentation, KOH-. Paraphyses cellular, straight, sparingly branched and anastomosing, apical cell slightly swollen, length to width ratio 6:1. Asci elongate-clavate, with a well developed tholus with a paler, conical masse axiale. Ascospores eight in the ascus, simple or uniseptate, colorless, ovoid, ellipsoid to fusiform, smooth-walled, without a halo, (4.5-) 5-20 x 2-5 µm.

Pycnidia spherical, immersed in the thallus to superficial, outer wall tan to reddish-brown, ostiole pale to brown pigmented. Conidiogenous cells enteroblastic, cylindrical to flask-shaped, arising directly from pycnidial wall cells or in groups of 2-3 at the tips of simple or branched condiophores that arise from the wall cells. Conidia rod-shaped, straight or bent, 7-15 x 0.5-1 µm (Fig. 1).

Phyllopsora is narrowly defined to include only species fitting all of the following diagnostic characteristics: thallus squamulose, small foliose, rarely crustose; lower surface not corticate, prothallus always present; apothecia biatorine, exciple and hypothecium of the same tissue type as the paraphyses; paraphyses highly gelatinized, length to width ratio 6:1; ascospores simple or once septate, ovoid to short-fusiform, less than 20 µm long, colorless, thin-walled.

Phyllopsora has a largely pantropical distribution, with a single species extending into northern Europe. Most species of Phyllopsora are corticolous. Some also grow on rocks or on bryophytes, but they are rarely found on leaves or dead wood. The altitudinal range of the genus is from sea level to

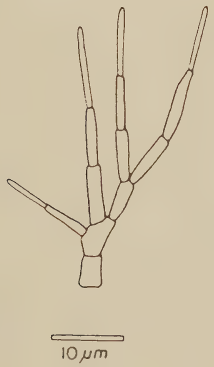


Fig. 1. Conidiogenous cells and conidia of the type found in Phyllopsora and Squamacidia (scale =10 µm).

3000 m; species of Phyllopsora are most common in humid, subtropical montane forests between 500 and 2000 m. In drier areas such as savannas, Phyllopsora is restricted to gallery forests.

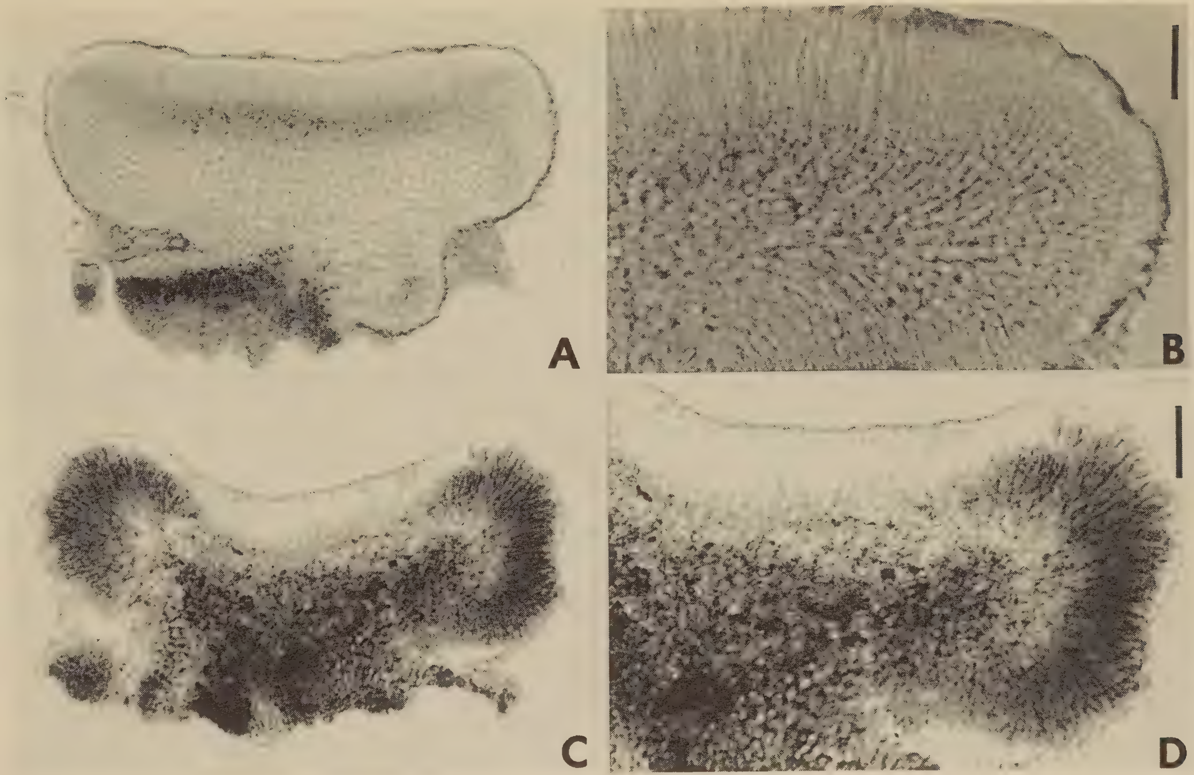
Phyllopsora is included in the lichen family Bacidiaceae based on its thallus form, its biatorine apothecia with radiate exciple, true paraphyses, and thick-walled asci with an amyloid hemispheric dome containing a narrow conical nonamyloid masse axiale. Phyllopsora may be separated from other genera by the combined characters of its ascal type, its apothecia composed of highly gelatinized hyphae with no clear distinction between the exciple and hypothecium, the same tissue type in the center and at the margin (Fig. 2A & B), and by its small, thin-walled, rarely septate ascospores.

Bacidia De Not., typified by B. rosella (Pers.) De Not., has an apothecial pattern with a cup-shaped exciple and distinct hypothecium and subhymenium of different tissue types. The ascospores are multiseptate and thick-walled. Bacidia as currently recognized is heterogeneous; it is a very large genus of several hundred species widespread in tropical and temperate areas, and is in great need of clarification.

Biatora Th. Fr., typified by B. vernalis (L.) Th. Fr., can be distinguished from Phyllopsora by its ascal type. It has the basic type found in the family with the addition of a darker-staining area around the masse axiale. Biatora vernalis has the same apothecial anatomy as Phyllopsora with larger, thicker-walled ascospores. Also, B. vernalis has a crustose thallus and appears to be primarily a temperate genus. Biatora efflorescens Nyl., an unusual sorediate species, also resembles Phyllopsora in apothecial anatomy and has argopsin, which may support a close relationship of Biatora and Phyllopsora.

Eschatogonia Trevisan, a genus comprising a few tropical species that have squamulose thalli, often grows together with Phyllopsora. It can be distinguished from Phyllopsora by its apothecial anatomy, with a distinct subhymenium, its chemistry including didymic acid and related substances, and by the presence of a lower cortex. The cortex has a distinct outer layer of uniformly arranged cells. The ascospores are slightly larger than those found in Phyllopsora, and are usually septate.

Fig. 2- A) Phyllopsora parvifolia (Pers.) Müll. Arg., Brazil, Campos do Jordão, Kalb & Plöbst 23 (NY), section through ascocarp (scale =60 μm), B) close-up of the excipulum (scale =25 μm), C) Squamacidia janeirensis (Müll. Arg.) Brako, Brazil, Serra do Cachimbo, Brako & Dibben 6917A (INPA, NY, US), section through the ascocarp (scale =60 μm), D) close-up of the excipulum (scale =50 μm).


A
B
C
D

Psorella Müll. Arg., typified by P. pannarioides (Knight) Müll. Arg., is probably a synonym of Bacidia. Psorella pannarioides agrees with Bacidia in its apothecial anatomy and long, thick-walled ascospores. Following Swinscow & Krog (1981), two of the original 14 taxa included in Psorella by Zahlbruckner (1926-1927), Psorella leptosperma (Müll. Arg.) Zahlbr. and P. spruceana (Müll. Arg.) Zahlbr., are regarded as belonging to Bacidia, and P. tryptophyllina (Nyl.) Zahlbr. is regarded as possibly belonging to Eschatogonia. Psorella delusa (Nyl.) Zahlbr., P. leucophyllina (Nyl.) Zahlbr. and P. psorina (Nyl. ex Hue) Zahlbr. are not congeneric with P. pannarioides, nor with each other, but cannot be assigned to any currently recognized genera. Swinscow & Krog (1981) transferred four species of Psorella to Phyllopsora. Two of the species they transferred to Phyllopsora, P. microphyllina (Tuck. ex Nyl.) Swinscow & Krog and P. pertexta (Nyl.) Swinscow & Krog, together with Psorella cognata (Nyl.) Zahlbr., differ from Phyllopsora by possessing different tissue types in the exciple and hypothecium, thinner, less gelatinized paraphyses and long, septate, filiform ascospores. The apothecial anatomy and thinner-walled ascospores separate these species from Bacidia rosella. Before a new genus can be described for this group, more studies are needed on the anatomy of the ascus, as there appears to be much variation in the development of the tholus and masse axiale. Also, it is highly likely that additional taxa previously included in Bacidia will prove to be congeneric with this group. These species remain a subject of continuing study.

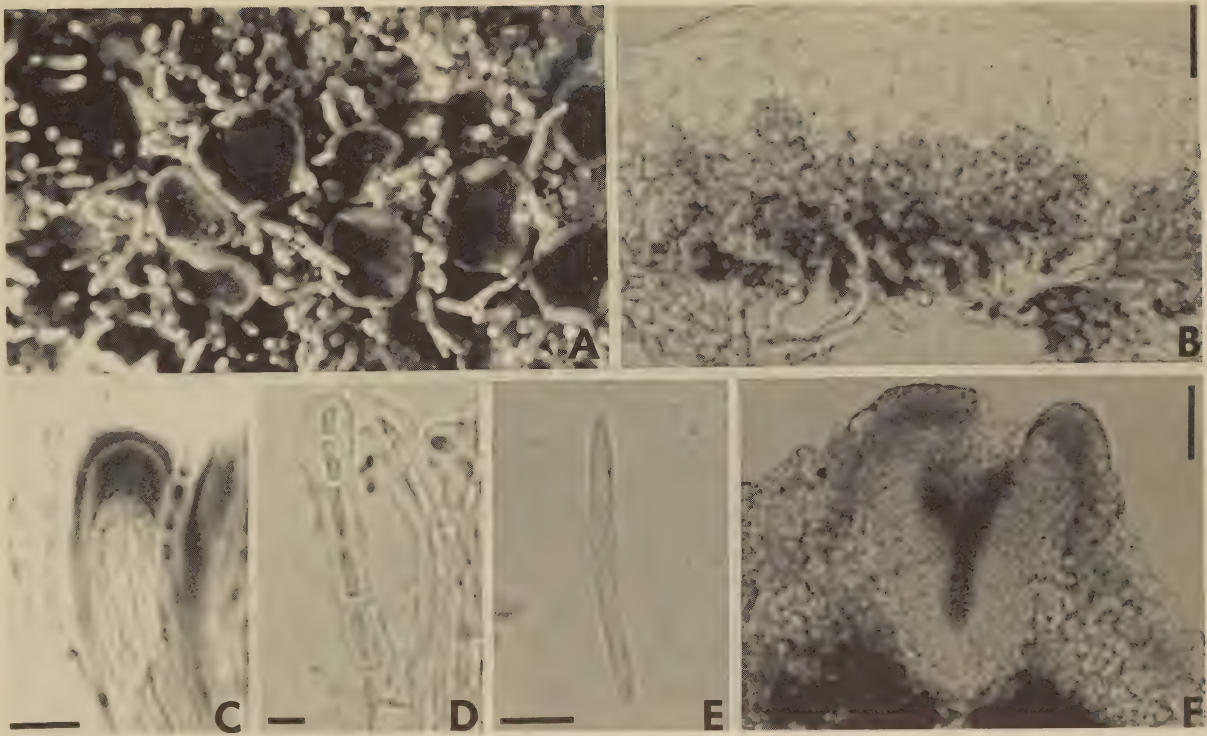
Swinscow & Krog (1981) also transferred Psorella janeirensis (Müll. Arg.) Zahlbr. to Phyllopsora based on study of the type specimen. After examination of additional material of this species, it is clear that it belongs with Phyllopsora stenosperma Zahlbr. and Physcidia endococcinea Zahlbr. in a new genus which is described below:

Squamacidia Brako, gen. nov.

A Phyllopsora ascosporis elongatis acerosis septatis, excipulo crasso pallido, granulas refractiles continenti, necnon acido lobarico et acido fumarprotocetrarico differt.

Type: Squamacidia janeirensis (Müll. Arg.) Brako. Figs. 1, 2C & D, 3A-F.

Fig. 3- Squamacidia janeirensis (Müll. Arg.) Brako, Brazil, Serra do Cachimbo, Brako & Dibben 6917A (INPA, NY, US). A) Thallus (12x), B) transverse section through the thallus (scale =20 μm), C) ascus tip (scale =10 μm), D) paraphyses (scale =5 μm), E) ascospore (scale =10 μm), F) section through pycnidium (scale =30 μm).


A
B
C
D
E
F

Thallus squamulose, squamules elongate and incised, 0.3-0.5 mm diam., convex. Upper surface glabrous, fibrillose at the margin. Isidia cylindrical. Upper cortex 20-60 µm thick, consisting of anticlinally oriented, thick-walled hyphae with narrowly cylindrical lumina, containing lichen substances. Photobiont in a continuous layer, green, unicellular, 10-15 µm diam. Medulla poorly developed, composed of loosely woven and nonamyloid hyphae, containing lichen substances. Lower cortex absent. Prothallus pale. Lichen substances: atranorin, fumarprotocetraric acid, lobaric acid, unknown rf. 6 and pigments.

Apothecia to 1.5 mm diam., simple or aggregated, attached laminally to the squamules. Disc plane to convex, tan to dark reddish-brown, margin generally raised, paler than the disc. Exciple cup-shaped, composed of hyphae with broad lumina at the margin, containing refractile granules, KOH-. Hypothecium tan, KOH-. Hymenium 80 µm tall, amyloid, epihymenium indistinct. Paraphyses cellular, straight, sparingly branched and anastomosing, apical cell slightly swollen, length to width ratio 10:1. Asci elongate-clavate, with a well developed tholus and lightened, narrow, conical masse axiale. Ascospores eight in the ascus, simple to 2-3 septate, colorless, acerose, smooth-walled, 24-40 x 2-2.5 µm.

Pycnidia spherical, immersed in the thallus to superficial, outer wall tan to reddish-brown, ostiole pale to brown pigmented. Conidiogenous cells enteroblastic, cylindrical to flask-shaped, arising directly from pycnidial wall cells, or in groups of 2-3 at the tips of short condiophores that arise from the wall cells. Conidia rod-shaped, straight, 9-15 x 0.5-1 µm.

This monotypic genus is distinguished by its squamulose thallus, obvious prothallus, characteristic apothecial anatomy, its long, acerose ascospores and distinctive chemistry.

Squamacidia has a pantropical distribution. All known specimens are corticolous. The altitudinal range of the genus is from 180-1400 m. Squamacidia has been found both in shaded, humid rainforest habitats and in sun-exposed, dry savanna habitats.

Squamacidia janeirensis (Müll. Arg.) Brako, comb. nov.

Thalloidima janeirensis Müll. Arg., Hedwigia 31: 280. 1892. Psorella janeirensis (Müll. Arg.) Zahlbr., Cat. Lich. Univ. 4: 402. 1926. Phyllopsora janeirensis (Müll. Arg.) Swinscow & Krog, Lichenologist 3: 242. 1981. Type: Brazil. Rio de Janeiro: Portella s.n. (holotype, BM, fumarprotocetraric acid, lobaric acid; isotype, G).

Phyllopsora stenospora Zahlbr., Repert. Spec. Nov. Regni Veg. 33: 44. 1933. Type: Taiwan. Mt. Arisan, Toroyen, Asahina 170 (holotype, W, lobaric acid; isotype, NY).

Thallus squamulose, squamules incised, 0.3-0.5 mm diam., complanate, adjoined and overlapping, adnate to ascending. Upper surface glabrous, fibrillose at the margin, Pd+ orange. Cortex 20-60 µm thick. Isidia cylindrical. Prothallus pale. Lichen substances: lobaric acid, and/or fumarprotocetraric acid, unknown rf. 6, UV+ orange, and pigments.

Apothecia common. Disc plane, orange-brown to brown. Margin raised, paler than the disc. Exciple tan, containing refractile granules, KOH-. Hypothecium tan, KOH-. Hymenium tan, 60 µm tall, epihymenium indistinct. Ascospores simple to 2-3 septate, acerose, 24-40 x 2-2.5 µm.

Conidiomata pycnidial. Conidia rod-shaped, straight, 9-15 x 0.5-1 µm.

Distribution: West Indies, South America, Taiwan and the Philippine Islands.

Of the 27 specimens of the type variety studied, nine were found to contain lobaric acid together with fumarprotocetraric acid and unknown rf. 6; eight have lobaric acid and fumarprotocetraric acid; four have lobaric acid alone; three have lobaric acid and unknown rf. 6; one has fumarprotocetraric acid and unknown rf. 6, and two have only fumarprotocetraric acid. This variation in chemistry does not appear to follow any distributional pattern, as different chemical varieties generally occur sympatrically.

Specimens examined: CUBA. [Oriente:] Monte Verde, Wright s.n. p.p, Lich. Cub. 179 (FH-TUCK 1919, BUF, G=2x, H-NYL 20535, L=2x, M=2x, UPS, W).

JAMAICA. 21 Mar 1905, Cummings 48 (FH=2x, NY); 1885, Hart s.n. (FH-TUCK 3018), Hart 32D (NY).

VENEZUELA. Bolivar: Parque Nacional Canaima, Gran Sabana, road from Aeropuerto Luepa to Kavanayen, 10 Apr 1985, Brako 8172 (NY).

FRENCH GUIANA. Saül, 2 km SW of the village, "sentier Limonade", 180-210 m, 22 Aug 1986, Montfoort & Ek 142 (U).

BRAZIL. Acre: Slopes of Serra da Moa, 19 Apr 1971, Prance et al. 12132 (INPA, NY). Amazonas: Platô da Serra do Aracá (Serra Norte), 1100 m, 14 Feb 1984, Cisneros et al. 30, 50 (INPA, NY); Reserva Biológia de Campina INPA-SUFRAMA on the Manaus-Caracarai road at point 45 km from intersection of the Manaus-Itacoatiara road, 6 Nov 1977, Dumont et al. 117 (INPA, NY); Reserva Experimental do INPA, Manaus-Caracarai km 61, 3 Aug 1973, Prance et al. 18717 p.p. (INPA, NY). Minas Gerais: Serra do Espinhaço, Serra do Caraça, 8 Jul 1978, Kalb & Plöbst 31 (Hb. Kalb), 1300 m, 12 Jul 1978, Kalb & Plöbst 34 (Hb. Kalb). Pará: Serra do Cachimbo, 774 km N of Cuiabá, ca. 400 m, 22 Apr 1983, Brako & Dibben 5531, 5556 (INPA, NY), 5605, 5612 (INPA); 763 km N of Cuiabá, ca. 400 m, 22 Apr 1983, Brako & Dibben 5887 (INPA, NY); Aeroporto Cachimbo, ca. 20 km N of the border with Mato

Grosso, ca. 430-480 m, 27 Apr 1983, Brako & Dibben 6171 (INPA, NY); 780 km N of Cuiabá, ca. 430-480 m, 29 Apr 1983, Brako & Dibben 6394 (INPA, NY); cataracts on the Rio Curuá, 877 km N of Cuiabá, ca. 350-500 m, 2 May 1983, Brako & Dibben 6621 (INPA, NY), 7 May 1983, Brako & Dibben 6917A (INPA, NY).

PHILIPPINE ISLANDS. North Luzon: Prov. Baguio, 1400 m, 10 Aug 1983, Kalb & Schrögl s.n. (Hb. Kalb).

Squamacidia janeirensis var. **endococcinea** (Zahlbr.) Brako, comb. et stat. nov.

Physcidia endococcinea Zahlbr., Denkschr. Kaiserl. Akad. Wiss., Math.-Naturwiss., Kl. 83: 159. 1909. Type: Brazil. São Paulo: Itapecirica, near Barra Mansa, ca. 1000 m, 9 Jun 1901, Schiffner s.n. (holotype, W, fumarprotocetraric acid, lobaric acid).

Distribution: Panama, Venezuela and Brazil.

Variety endococcinea is distinguished by the straw-colored or scarlet-colored pigment in the medulla and frequent occurrence of atranorin. It is thus far known only from the neotropics.

Of the 13 specimens of this variety studied, three were found to contain atranorin together with fumarprotocetraric acid, lobaric acid and unknown rf. 6; two have atranorin, fumarprotocetraric acid and lobaric acid; two have fumarprotocetraric acid, lobaric acid and unknown rf. 6; one has fumarprotocetraric acid and lobaric acid; one has atranorin, lobaric acid and unknown rf. 6; two have atranorin and lobaric acid, and two have only lobaric acid. These chemical varieties do not appear to follow any distributional pattern.

Specimens examined: PANAMA. Panamá: Cerro Jefe, 900 m, 28 Nov 1985, Brako 8494 (NY).

VENEZUELA. Miranda: El Volcán, above Baruta, 1200-1400 m, 1 May 1986, Brako 8667 (NY).

BRAZIL. Amazonas: Along Igarapé Caititu off Rio Uatumá at Antônio Filinto, 18, 19 Aug 1979, Buck 2977, 2998 (INPA, NY); Reserva Biológica de Campina INPA-SUFRAMA, on the Manaus-Caracarai road at a point 45 km from the intersection of the Manaus-Itacoatiara road, 6 Nov 1977, Dumont BR-102 (INPA, NY); Rio Cuieras just below mouth of the Rio Brancinho, 27 Sep 1971, Prance et al. 14960 (INPA, NY). Pará: Serra do Cachimbo, 763 km N of Cuiabá, ca. 400 m, 22 Apr 1983, Brako & Dibben 5858 (INPA, NY), 24 Apr 1983, Brako & Dibben 5870 (INPA, NY); Aeroporto Cachimbo, ca. 20 km N of the border with Mato Grosso, ca. 430-480 m, 27 Apr 1983, Brako & Dibben 6185. Roraima: Along the Manaus-Boa Vista road at a point 350 km from the intersection of the Manaus-Itacoatiara road, 18 Nov 1977, Dumont et al. BR-599B, BR-600 (INPA, NY).

Squamacidia is included in the Bacidiaceae based on its thallus form, its biatorine apothecia, true paraphyses and bacidiacious ascal type. Squamacidia can be separated from Phyllopsora and other genera in the

Bacidiaceae by its thick apothecial margin (Fig. 2C & D), acerose ascospores (Fig. 2E) and distinct chemistry of fumarprotocetraric acid and/or lobaric acid. Apothecial anatomy is closest to that of Phyllopsora, but the texture of the center and the margin are different, and the hyphae of the exciple are expanded at the margin and covered with granules. The remaining taxa in Physcidia, P. squamulosa Tuck. and P. wrightii (Nyl.) Tuck., can be distinguished by their non-bacidiacious ascal type, lecanorine apothecia and chemistry of divaricatic acid and scrobiculin.

Key to Phyllopsora and associated genera

1a. Thallus with an upper and lower cortex comprised of a thin layer of cuboidal cells......... Eschatogonia

1b. Thallus lacking a lower cortex, upper cortex not as above.. 2

2a. Apothecia lecanorine, thallus containing divaricatic acid and scrobiculin...... Physcidia

2b. Apothecia biatorine, thallus lacking divaricatic acid............................... 3

3a. Apothecia with tissue types different in the center from the margin, spores over 20 µm long.................... 4

4a. Spores thick-walled, multiseptate, thallus containing atranorin.... Bacidia

4b. Spores thin-walled, simple to 2-3 septate, thallus containing fumarprotocetraric acid and/or lobaric acid........................ Squamacidia

3b. Apothecia with the same tissue type throughout, spores less than 20 µm long... 5

5a. Spores thick-walled, ascal tip with a darkened amyloid area around the masse axiale.................... Biatora

5b. Spores thin-walled, ascal tip lacking a darkened area around the masse axiale. .... Phyllopsora

In addition to reevaluating the generic concept of Phyllopsora, the species concept has also been reassessed. Most species had previously been distinguished by single differences of thalline characters, but the extent of environmental variability in these traits had never been critically evaluated. After field studies and examination of abundant new material, many character states were found to form a continuum and it became clear that certain taxa formerly considered species are more naturally considered as varieties, and certain taxa treated as varieties are actually distinct species. As a result of detailed study of the 51 species of Phyllopsora described from the neotropics (Brako, 1987), 25 names are reduced to synonymy and the following name changes are proposed:

Phyllopsora buettneri (Müll. Arg.) Zahlbr. var. **glauca** (B. de Lesd.) Brako, comb. nov.
Phyllopsora parvifolia (Pers.) Müll. Arg. var. glauca B. de Lesd., Rev. Bryol. Lichénol. 7: 60. 1934. Type: Cuba. [Oriente:] Loma del Gato, 1100 m, Jul 1931, Hioram 9098 (lectotype, HAC, designated by Vězda, 1969 in hb., fragment NY; isosyntype: Cuba. Scala Victoria, 800 m, Hioram 8909, UPS).
Phyllopsora melanoglauca Zahlbr., Denkschr. Kaiserl. Akad. Wiss., Math.-Naturwiss. Kl. 83: 133. 1909. Type: Brazil. São Paulo: Near Iguape, 20-100 m, Aug 1901, Schiffner s.n. (holotype, W; isotype, BM).

Phyllopsora buettneri (Müll. Arg.) Zahlbr. var. **munda** (Malme) Brako, comb. et stat. nov.
Lecidea munda Malme, Ark. Bot. 28A(7): 49. 1936. Phyllopsora munda (Malme) Zahlbr., Cat. Lich. Univ. 10: 377. 1939. Type: Brazil. Rio Grande do Sul: Hamburgerberg, near São Leopoldo, 18 Oct 1892, Malme s.n., Lich. Regnell. 617B (holotype, S).
Lecidea schizophylloides Malme, Ark. Bot. 28A(7): 45. 1936. Phyllopsora schizophylloides (Malme) G. Schneider, Biblioth. Lich. 13: 178. 1979. Type: Brazil. Rio Grande do Sul: Silveira Martins, 7 Mar 1893, Malme s.n., Lich. Regnell. 1251B (holotype, S).

Phyllopsora canoumbrina (Vainio) Brako, comb. nov.
Lecidea canoumbrina Vainio, Proc. Amer. Acad. Arts 58: 135. 1923. Type: Trinidad. Maraval Valley, Jan-Apr 1913, R. Thaxter 19 (holotype, FH).
Lecidea parvifolia Pers. f. subgranulosa Tuck., Proc. Amer. Acad. Arts 6: 273. 1866. Biatora parvifolia (Pers.) Mont. var. subgranulosa (Tuck.) Tuck., Syn. N. Amer. Lich. 2: 8. 1888. Psora parvifolia (Pers.) Massal. var. subgranulosa (Tuck.) Müll. Arg., J. Linn. Soc., Bot. 29: 219. 1893. Phyllopsora parvifolia (Pers.) Müll. Arg. var. subgranulosa (Tuck.) Müll. Arg., Bot. Jahrb. Syst. 20: 264. 1894. Type: Cuba. [Oriente:] Monte Verde, 6 Apr, Wright s.n., Lich. Cub. 185 (lectotype here designated, FH-TUCK 2923, piece

marked "w"; isolectotypes, BM, BUF, G=3x, L=2x, L-6889, M, UPS, US).

Phyllopsora corallina (Eschw.) Müll. Arg. var. **glaucella** (Vainio) Brako, comb. nov.

Lecidea breviuscula (Nyl.) Müll. Arg. var. glaucella Vainio, Dansk Bot. Arkiv 4(11): 21. 1926. Phyllopsora breviuscula (Nyl.) Müll. Arg. var. glaucella (Vainio) Zahlbr., Cat. Lich. Univ. 10: 426. 1939 "fo. glaucina". Type: Mexico. Veracruz: Mirador, Liebmann s.n., Pl. Mex. 7381a (holotype, TUR-VAIN 34026).

Phyllopsora corallina (Eschw.) Müll. Arg. var. **ochroxantha** (Nyl.) Brako, comb. et stat. nov.

Lecidea ochroxantha Nyl., Ann. Sci. Nat. Bot., sér. 4, 11: 223. 1859. Phyllopsora ochroxantha (Nyl.) Zahlbr., Cat. Lich. Univ. 10: 377. 1939. Type: Bolivia. Camplolicans, [1847,] Weddell s.n. (lectotype designated by Swinscow & Krog, 1981, H-NYL 20489; isolectotypes H, PC).

Lecidea subvirescens Nyl., Ann. Sci. Nat. Bot., sér. 5, 7: 321. 1867. Phyllopsora subvirescens (Nyl.) G. Schneider, Biblioth. Lich. 13: 179. 1979. Type: Venezuela. Río Negro, 1200 m, 1863, Lindig s.n. (holotype, H-NYL 20492).

Lecidea ernstiana Müll. Arg., Flora 60: 473. 1877. Psora ernstiana (Müll. Arg.) Müll. Arg., Flora 70: 320. 1887. Phyllopsora ernstiana (Müll. Arg.) Müll. Arg., Bot. Jahrb. Syst. 20: 265. 1894. Type: Venezuela. Distrito Federal: Caracas, Ernst 90 (holotype, G).

Psora polydactyla Müll. Arg., Flora 70: 320. 1887. Phyllopsora polydactyla (Müll. Arg.) Zahlbr., Cat. Lich. Univ. 4: 400. 1926. Type: Brazil. São Paulo: Apiahy (Apiaí), Apr 1882, Puiggari 2156 (holotype, G).

Lecidea spinulosa Vainio, Acta Soc. Fauna Fl. Fenn. 2: 46. 1890. Phyllopsora spinulosa (Vainio) Zahlbr., Cat. Lich. Univ. 4: 401. 1926. Type: Brazil. Minas Gerais: Sitio, 1885, Vainio s.n., Lich. Bras. Exs. 993 (holotype, TUR-VAIN 22627; isotypes, BM=2x, M, TUR-VAIN 22626, ZT).

Lecidea glabriuscula Nyl., Sert. lich. trop. 40. 1891. Phyllopsora glabriuscula (Nyl.) Swinscow & Krog, Lichenologist 13: 241. 1981. Type: Cuba. Wright s.n., Lich. Cub. ser. 2, 105 (holotype, H-NYL 20534).

Phyllopsora cinerella Zahlbr. in H. Magn. & Zahlbr., Ark. Bot. 3IA(6): 18. 1944. Type: U.S.A. Hawaii: Kauai, near Robinson’s summerhouse, 1000 m, Feb 1910, Faurie 308 (lectotype here designated, PC; syntypes, Faurie 307, UPS, Maui, 350 m, Faurie 539, n.v.).

Phyllopsora cinerella Zahlbr. f. virescens Zahlbr. in H. Magn. & Zahlbr., Ark. Bot. 31A(6): 19. 1944. Type: U.S.A. Hawaii: Oahu, near Honolulu, 400 m, Faurie 413 (lectotype here designated, PC; isolectotype, BM).

Phyllopsora martinii Swinscow & Krog, Lichenologist 3: 232. 1981. Type: Kenya. Coast Prov.: Kwale District, Shimba Hills, Kivumoni Forest, 350 m, 1972, Krog & Swinscow K 42/3 (holotype BM; isotypes, BM, O, UPS).

Phyllopsora corallina (Eschw.) Müll. Arg. var. **phaeobyssina** (Vainio) Brako, comb. nov.

Lecidea breviuscula Nyl. var. phaeobyssina Vainio, Ann. Acad. Sci. Fenn., ser. A, 6(7): 127. 1915. Phyllopsora breviuscula (Nyl.) Müll. Arg. var. phaeobyssina (Vainio) Zahlbr., Cat. Lich. Univ. 4: 396. 1926. Type: Guadeloupe. Houelmont, [1897,] Duss 481 (holotype, TUR-VAIN 22602; isotype, NY).

Phyllopsora corallina (Eschw.) Müll. Arg. var. **santensis** (Tuck.) Brako, comb. et stat. nov.

Lecidea santensis Tuck., Amer. J. Sci. Arts, ser. 2, 25: 428. 1858. Phyllopsora santensis (Tuck.) Swinscow & Krog, Lichenologist 13: 236. 1981. Type: U.S.A. South Carolina: [Berkeley Co.,] Santee Canal, 1849, Ravenel 182 (holotype, FH-TUCK 2822).

Phyllopsora albicans Müll. Arg., Bull. Soc. Roy. Bot. Belgique 32: 132. 1893. Type: Costa Rica. Cartago: Terraba (Turrialba), 1893, Tonduz s.n. (holotype, G; isotypes, US=2x, as Pittier & Durand, Pl. Costar. Exs. 5474).

Lecidea porphyromelaena Vainio, Ann. Acad. Sci. Fenn., ser. A, 15(6): 113. 1921. Phyllopsora porphyromelaena (Vainio) Zahlbr., Cat. Lich. Univ. 4: 401. 1926. Type: Philippines. Luzon: Bataan Prov., Mount Marivales, Dec 1908, Merrill s.n., Bur. Sci. 6273 (lectotype designated by Swinscow & Krog, 1981, TUR-VAIN 22619; syntype, Bur. Sci. 6256, TUR-VAIN 22620; isosyntypes, BM, US).

Lecidea miradorensis Vainio, Dansk Bot. Ark. 4(11): 22. 1926. Phyllopsora miradorensis (Vainio) G. Schneider, Biblioth. Lich. 13: 177. 1979. Type: Mexico. [Veracruz:] Mirador, 18 Mar 1842, Liebmann s.n., Pl. Mex. 7373 (lectotype designated by Swinscow & Krog, 1981, TUR-VAIN 34034; isolectotype, FH; syntype, Liebmann s.n., Pl. Mex. 7372A, TUR-VAIN 34035).

Phyllopsora formosana Zahlbr., Repert. Spec. Nov. Regni Veg. 33: 43. 1933. Type: Taiwan. Raisha, 5 Jan 1925, Asahina s.n. (holotype, W).

Lecidea corallina Eschw. f. saxicola Malme, Ark. Bot. 28A(7): 47. 1936. Type: Brazil. Mato Grosso:

Santo Antônio near Cuiabá, Morrinho, 24 Apr 1894, Malme s.n., Lich. Regnell. 2607B (holotype, S).

Phyllopsora minor Brako, nom. nov.
Lecidea corallina Eschw. var. schizophylloides Vainio, J. Bot. 34: 106. 1896. Phyllopsora corallina (Eschw.) Müll. Arg. var. schizophylloides (Vainio) Zahlbr., Cat. Lich. Univ. 4: 397. 1926 (non Phyllopsora schizophylloides (Malme) Schneider =Phyllopsora buettneri (Müll. Arg.) Zahlbr. var. munda (Malme) Brako). Type: St. Vincent. Richmond Peak, 1000-2000 m, Elliott 261 (lectotype designated by Swinscow & Krog, 1981, TUR-VAIN 22612A; isolectotype, BM).

Phyllopsora parvifolia (Pers.) Müll. Arg. var. **breviuscula** (Nyl.) Brako, comb. et stat. nov.
Phyllopsora breviuscula (Nyl.) Müll. Arg., Bull. Herb. Boissier 2(Appendix 1): 45. 1894. Lecidea breviuscula Nyl., Ann. Sci. Nat. Bot., sér. 4, 19: 339. 1863. Lecidea parvifolia* breviuscula (Nyl.) Nyl., Ann. Sci. Nat. Bot., sér. 5, 7: 321. 1867. Psora breviuscula (Nyl.) Müll. Arg., Flora 65: 483. 1882. Type: Cuba. [Oriente:] Monte Verde, Wright s.n. (holotype, H-NYL 20557; isotypes as Lich. Cub. 181, B, BM, G=3x, L=2x, UPS).
Phyllopsora brachyspora Müll. Arg., Bot. Jahrb. Syst. 20: 264. 1894. Type: Tanzania. "Hochwald ob Kwa Mstufa in Usambara, D.O. Afr.", 1894, Holst 9181 p.p. (holotype, G; isotypes, BM, M, W).

Phyllopsora subcrustacea (Malme) Brako, comb. et stat. nov.
Lecidea corallina Eschw. var. subcrustacea Malme, Ark. Bot. 28A(7): 47. 1936. Phyllopsora corallina (Eschw.) Müll. Arg. var. subcrustacea (Malme) Zahlbr., Cat. Lich. Univ. 10: 377. 1939. Type: Paraguay. Asunción, 18 Aug 1893, Malme s.n., Lich. Regnell. 1612B (holotype, S; isotype, UPS).

The following taxa, previously assigned to Phyllopsora, do not belong to the genus as currently delimited and are placed in other genera (indicated in boldface):

Lecidea aleuroides Stirton, J. Linn. Bot. 14: 469. 1875.
Phyllopsora aleuroides (Stirton) Müll. Arg., Bull. Herb. Boissier 2(Appendix 1): 45. 1894. Type. New Zealand. Near Wellington, Buchanan s.n. (lectotype designated by Galloway 1983, GLAM; isolectotypes, BM, WELT).
=**Psoromidium aleuroides** (Stirton) D. Galloway

Lecidea congregans Zahlbr., Akad. Wiss. Wien, Math-Naturwiss. Kl., Denkschr. 104: 305. 1941. *Phyllopsora congregans* (Zahlbr.) D. Galloway, New Zealand J. Bot. 21: 196. 1983. Type: New Zealand. Otago, Mt. Cargill near Dunedin, 400 m, May 1935, *J.S. Thomson A96* (lectotype, W3424).
=***Trapeliopsis congregans*** (Zahlbr.) Brako, comb. nov.

Lecidea coroniformis Krempelh., Verh. Zool.-Bot. Ges. Wien 18: 327. 1868. *Phyllopsora coroniformis* (Krempelh.) Zahlbr. in Engler & Prantl, Nat. Pflanzenfam. 1(1*): 139. 1905. *Biatora coroniformis* (Krempelh.) Jatta, Flora Ital. Cryptog., 3: 520. 1911. Type: USA. Texas, Ex. hb. Endichler (holotype, M).
=***Psora crenata*** (Tayl.) Reinke

Phyllopsora cryptocarpa Riddle, Mycologia 15: 80. 1923. Type: Cuba. Isle of Pines: San Juan, 15 Mar 1916, *Britton et al. 15588* (holotype, FH; isotype FH, NY).
=***Fellhanera cryptocarpa*** (Riddle) Brako, comb. nov.

Phyllopsora leprosa W. Riedl, Österr. Bot. Z. 121: 145. 1973. Type: Surinam. 1827, *Weigel s.n.* (holotype, W).
=***Crocynia gossypina*** (Sw.) Massal.

Phyllopsora melanocarpa Müll. Arg., Hedwigia 34: 28. 1895. Type: Australia. Victoria, *Wilson 150* (holotype, G; isotype W).
=***Neophyllis pachyphylla*** (Müll. Arg.) G. Schneider

Phyllopsora subcorallina Zahlbr., Ann. Mycol. 33: 43. 1935. Type: U.S.A. Florida: Sanford, Mar 1928, *Rapp 70* (lectotype here designated, W; syntype, *Rapp 69*, FH).
=***Catinaria subcorallina*** (Zahlbr.) Brako

Phyllopsora subfilamentosa Zahlbr., Ann. Mycol. 33: 44. 1935. Type: U.S.A. Florida: Sanford, *Rapp 62* (holotype, W).
=***Fuscidea subfilamentosa*** (Zahlbr.) Brako

Psoromidium wellingtonii Stirton, Proc. Phil. Soc. Glasgow 10: 304. 1877. *Phyllopsora wellingtonii* (Stirton) Müll. Arg., Bull. Herb. Boissier 2(Appendix 1): 45. 1894. Type: New Zealand. Near Wellington, *J. Buchanan s.n.* (lectotype designated by D. Galloway, 1983, BM).
=***Psoromidium aleuroides*** (Stirton) D. Galloway

The following taxa are also excluded from Phyllopsora, but do not belong to any currently recognized genera and are here listed alphabetically by their basionyms:

Biatora pyrrhomelaena Tuck., Amer. J. Sci. Arts, ser. 2, 28: 205. 1859. Phyllopsora pyrrhomelaena (Tuck.) Swinscow & Krog, Lichenologist 13: 244. 1981. Type: Cuba. [Oriente:] Monte Verde Woods, 7 Apr, Wright s.n., Lich. Cub. 178 (holotype, FH; isotypes, BM, BUF, L=2x, UPS, US=2x).
This species belongs in an undescribed genus in the Bacidiaceae. It differs from Phyllopsora by its apothecial anatomy and pigmentation.

Lecidea curatellae Malme, Ark. Bot. 28A(7): 42. 1936. Phyllopsora curatellae (Malme) G. Schneider, Biblioth. Lich. 13: 175. 1979. Type: Brazil. Mato Grosso: Cuiabá, 27 Nov 1893, Malme s.n., Lich. Regnell. 2038 (lectotype designated by Swinscow & Krog, 1981, S; isolectotype, UPS).
This species belongs to an undescribed genus in the Lecanoraceae based on its ascal type, dark hypothecium and small ascospores.

Lecidea leucophyllina Nyl., Ann. Sci. Nat. Bot., sér. 4, 19: 347. 1863. Thalloidima leucophyllinum (Nyl.) Müll. Arg., Rev. Mycol. 10: 60. 1888. Biatora leucophyllina (Nyl.) Tuck., Synop. N. Amer. Lich. 2: 40. 1888. Psorella leucophyllina (Nyl.) Zahlbr., Cat. Lich. Univ. 4: 402. 1926. Type: Cuba. Wright s.n. (holotype, H-NYL 17345C,E; isotypes as Lich. Cub. 213, BM=2x, BUF, FH-TUCK 3018, FH, G=3x, L=2x, UPS).
This species belongs to an undescribed genus in the Bacidiaceae based on its ascal type, its sorediate thallus containing sekikaic acid, its apothecia with refractile granules, and its long septate, thin-walled ascospores.

Lecidea stylophora Malme, Ark. Bot. 28A(7): 40. 1936. Phyllopsora stylophora (Malme) G. Schneider, Biblioth. Lich. 13: 179. 1979. Type: Brazil. Mato Grosso: Serra da Chapada, Burutí, 27 Jun 1894, Malme s.n. (holotype, S; isotypes, G, H, US).
This species belongs in the Lecanoraceae based on the ascal type characteristic of the family and simple, hyaline, broad ascospores.

Lecidea thaleriza Stirton, Trans. Glasgow Soc. Field Nat. 5: 217. 1877. Phyllopsora thaleriza (Stirton) G. Schneider, Biblioth. Lich. 13: 180. 1979. Type: South Africa. Somerset East, Boschberg, 1874, McOwan s.n. (holotype, BM; not found in GLAM).

Psora compaginata Müll. Arg., Rev. Mycol. 10: 60. 1888. Phyllopsora compaginata (Müll. Arg.) G. Schneider, Biblioth. Lich. 13: 175. 1979. Type: Paraguay. Cerro San Thomas, Jun 1881, Balansa 4134 (holotype, G, isotypes, M, W; possible isotype, H-NYL 4132).

This species belongs to an undescribed genus in the Bacidiaceae. It differs from Phyllopsora by its pseudoparenchymatous hypothecium, its crustose thallus and its algal type which does not agree well with Pseudochlorella.

Phyllopsora longispora Swinscow & Krog, Nord. J. Bot. 5:493. 1985. Type: Kenya. Western Prov.: Kakamega District, Kakamega Forest, 1700 m, 20 Jan 1970, Santesson 21698A (holotype, UPS).

This species belongs to an undescribed genus in the the Bacidiaceae. It has a squamulose thallus like Phyllopsora, an apothecial anatomy like Bacidia rosella and long filiform thin-walled ascospores. It is only known from the type collection.

Full synonymy and additional nomenclatural changes in Phyllopsora will be included in forthcoming publications.

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FOUR NEW SPECIES OF PARMELIA (LICHENES) FROM SOUTHERN AFRICA, WITH FURTHER NOTES, NEW COMBINATIONS AND NEW LICHEN RECORDS

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ABSTRACT

Four new species of *Parmelia* (Parmeliaceae, lichenized Ascomycotina) are described from southern Africa. They are: *Parmelia dwaasbergensis* Brusse, *P. inops* Brusse, *P. lyrigera* Brusse, and *P. sitiens* Brusse. Two new combinations are made: *Parmelia evernica* (Hale) Brusse and *P. rubropustulata* (Hale) Brusse. Two lichens are recorded for the first time from southern Africa and notes on seven *Parmelia* species are given.

PARMELIA DWAASBERGENSIS Brusse, *sp. nov.* Fig. 2

Thallus foliosus, saxicola, ad 5 cm diametro, laxe adnatus, 85 - 175 µm crassus. *Lobi* elongati, imbricati, 0,5 - 3,0 mm lati. *Thallus superne* cinereus, nitidus, isidiis sorediisque destitutus. *Cortex superior* 13 - 15 µm crassus. *Stratum gonidiale* 15 - 45 µm crassum, algis *Trebouxiis*, 6,5 - 16,5 µm diametris. *Medulla* alba, 45 - 95 µm crassa. *Cortex inferior* 8 - 11 µm crassus. *Thallus inferne* piceus, sat rhizinatus. *Rhizinae* simplices, 40 - 100 µm crassae. *Apothecia et pycnidia* non visa. *Thallus* atranorinum, acidum hypostictícum, acidum hyposalazinicum et acidum hypoconsticticum continens.

TYPUS: SOUTH AFRICA, CAPE PROVINCE - 3323 (Willowmore): 7 km S of road junction near Misgunst Farm, farm Krommekloof, E side of Dwaasberg hill. Table Mountain Sandstone outcrop on SW slope, on SW face. Alt. 1060 m (-CB). *F. Brusse 5211*, 8. iii. 1988 (PRE, holo-; BM, COLO, LD, iso-).

Figura 2.

Thallus foliose, saxicolous, to 5 cm across, loosely adnate, 85 - 175 µm thick. *Lobes* elongate, imbricate, 0,5 - 3,0 mm broad. *Upper surface* grey, glossy, without isidia or soredia. *Upper cortex* 13 - 15 µm thick. *Algal layer* 15 - 45 µm thick, algae *Trebouxia*, 6,5 - 16,5 µm diam. *Medulla* white, 45 - 95 µm thick. *Lower cortex* 8 - 11 µm thick. *Lower surface* black, moderately rhizinate. *Rhizines* simple, 40 - 100 µm thick. *Apothecia and pycnidia* not seen. *Chemistry:* atranorin, hypostictic, hyposalazinic, and hypoconstictic acids present.

This new species is probably most closely related to the Australian, *Paraparmelia brownliei* Elix & Johnston (1988) with a chestnut brown lower surface. *Parmelia dwaasbergensis* is black below, and is more loosely adnate and broader lobed than *P. brownliei*. In addition, *P. brownliei* contains hypostictic acid as the only major medullary constituent, hypoconstictic acid being found in minor quantities, and hyposalazinic acid being present only in trace amounts. *Parmelia dwaasbergensis*, on the other hand, contains these substances in more or less equal concentrations (i.e. all three substances are present in major amounts).

Parmelia dwaasbergensis is also related to the following species to be described new, *Parmelia inops*, but is also more loosely adnate and broader-lobed than the latter.

Other *Paraparmelia*'s containing hypostictic acid are isidiate.

The habit of this lichen resembles loose forms of *Parmelia vanderbylii* Zahlbr. (sometimes referred to as a distinct species, *P. prolata* Hale). This loose habit is also frequently found in *P. tortula* Kurok., which this new lichen may also resemble.

At present this new species is known only from the type locality, the east side of a hill called Dwaasberg, northeast of Uniondale.

PARMELIA INOPS Brusse, *sp. nov.* Fig. 3

Thallus minute foliosus, saxicola, ad 3,5 cm diametro. *Lobi* elongati vel sublineares, 0,2 - 1,0 mm lati, 65 - 160 µm crassi. *Thallus superne* cinereus, nitidus, isidiis sorediisque destitutus. *Cortex superior* 9 - 16 µm crassus. *Stratum gonidiale* 15 - 30 µm crassum, algis *Trebouxiis*, 5,5 - 17 µm diametris. *Medulla* alba, 30 - 110 µm crassa. *Cortex inferior* 7 - 12 µm crassus. *Thallus inferne* piceus, sat rhizinatus. *Rhizinae* simplices, 35 - 55 µm crassae. *Apothecia*

adnata, ad 1,5 mm diametris. *Hypothecium* hyalinum, 13 - 35 µm crassum. *Subhymenium* hyalinum, 9 - 12 µm crassum, J+ pallide caeruleum. *Hymenium* hyalinum, 45 - 50 µm altum, J+ caeruleum. *Asci* clavati, tholis J+ caeruleis (figura 1). *Ascosporae* octonae, hyalinae, simplices, ellipsoideae, 7,5 - 12,0 X 4,5 - 7,0 µm. *Pycnidia* non visa. *Thallus* atranorinum, acidum hyposticticum, acidum hyposalazinicum et acidum hypoconsticticum continens.

TYPUS: SOUTH AFRICA, CAPE PROVINCE - 3323 (Willowmore): 7 km S of road junction at Misgunst Farm, farm Krommekloof, E side of Dwaasberg hill. Near S base of Table Mountain Sandstone outcrop, on SW slope. Alt. 1060 m (-CB). *F. Brusse 5212*, 8. iii. 1988 (PRE, holo-; BM, COLO, LD, iso-). Figura 3.

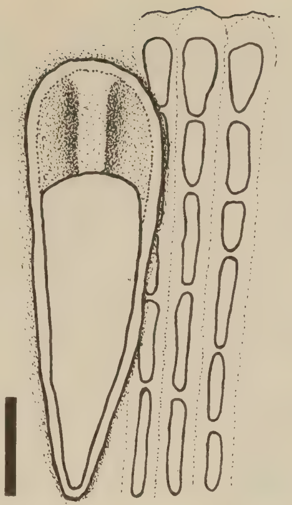


FIGURE 1. *Parmelia inops* Brusse, ascus and paraphyses. *F. Brusse 5212*, holotype. Bar = 10 µm.

Thallus minutely foliose, saxicolous, to 3,5 cm across. *Lobes* elongate to sublinear, 0,2 - 1,0 mm broad, 65 - 160 µm thick. *Upper surface* grey, glossy, without isidia or soredia. *Upper cortex* 9 - 16 µm thick. *Algal layer* 15 - 30 µm thick, algae *Trebouxia*, 5,5 - 17 µm diam. *Medulla* white, 30 - 110 µm thick. *Lower cortex* 7 - 12 µm thick. *Under surface* black, moderately rhizinate. *Rhizines* simple, 35 - 55 µm thick. *Apothecia* adnate, to 1,5 mm across. *Hypothecium* hyaline, 13 - 35 µm thick. *Subhymenium* hyaline, 9 - 12 µm thick, J+ pale blue. *Hymenium* hyaline, 45 - 50 µm high, J+ blue. *Asci* clavate, eight-spored, tholus J+ blue (figure 1). *Ascospores* hyaline, simple, ellipsoid, 7,5 - 12,0 X 4,5 - 7,0 µm. *Pycnidia* not seen. *Chemistry:* atranorin, hypostictic, hyposalazinic and hypoconstictic acids present.

This new species is probably most closely related to the Australian, *Paraparmelia brownliei* Elix & Johnston (1988), with a chestnut brown lower surface. *Parmelia inops* is black below, and is tighter and more narrow lobed than *P. brownliei*. *Paraparmelia brownliei* contains hypostictic acid as the only major medullary substance, hypoconstictic acid being found as a minor constituent, and only traces of hyposalazinic acid are present. In contrast, *P. inops* contains

these substances in approximately equal concentrations (i.e. all three substances are present in major amounts).

Parmelia inops is also related to the previous new species from the same locality, *P. dwaasbergensis*, but is tighter and more narrow-lobed than the latter.

This new species resembles the more common, *P. xanthomelanoides* (Elix & Nash) Brusse (1988b), but contains the hypostictic acid series instead of the stictic acid series.

Paraparmelia subtropica Elix & Johnston (1986) may be close to the hypothetical isidiate counterpart of this species, but the lobes are elongate, not sublinear as in *P. inops*, and contains norstictic acid as the major constituent, with only traces of hypostictic and hyposalazinic acids.

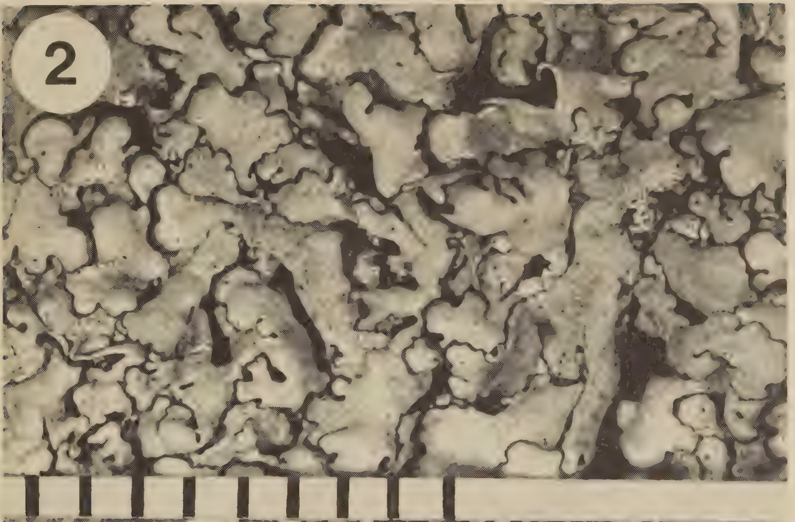
At present this new species is known only from the type collection, from just east of Dwaasberg hill, north-east of Uniondale.

PARMELIA LYRIGERA Brusse, *sp. nov.* Fig. 4

Thallus crustosus et effiguratus, saxicola, ad 3 cm diametro. *Lobi* elongati, 0,2 - 0,7 mm lati, 65 - 100 µm crassi. *Thallus superne* flavo-viridis, subnitidus vel grosse pruinosus, isidiatus. *Isidia* 0,05 - 0,1 mm crassa. *Cortex superior* 15 - 20 µm crassus. *Stratum gonidiale* 20 - 35 µm crassum, algis *Trebouxiis*, 5 - 18,5 µm diametris. *Medulla* alba, 20 - 40 µm crassa. *Cortex inferior* 10 - 13 µm crassus. *Thallus inferne* piceus. *Rhizinae* non bene evolutae. *Apothecia* non visa. *Pycnidia* hyalina, globosa, 110 - 150 µm profunda, 90 - 110 µm lata. *Pycnidiosporae* hyalinae, aciculares, 6 - 9 X 0,8 µm. *Thallus* acidum usnicum, acidum hypostictIcum, acidum hyposalazinicum et acidum hypoconsticticum continens.

TYPUS: SOUTH AFRICA, CAPE PROVINCE - 2630 (Carolina): 7 km from Amsterdam to Nerston, farm Tweepoort, hill slope with SW aspect. On basic rocks of the Ususwhana complex. Alt. 1440 m (-DA). *F. Brusse 5564*, 13. v. 1988 (PRE, holo-; BM, COLO, iso-). Figura 4.

Thallus effigurate-crustose, saxicolous, to 3 cm across. *Lobes* elongate, 0,2 - 0,7 mm broad, 65 - 100 µm thick. *Upper surface* yellow-green, subnitid to coarse-pruinose, isidiate. *Isidia* 0,05 - 0,1 mm thick. *Upper cortex* 15 - 20 µm thick. *Algal layer* 20 - 35 µm thick, algae *Trebouxia*, 5 - 18,5 µm diam. *Medulla* white, 20 - 40 µm thick. *Lower cortex* 10 - 13 µm thick. *Lower surface* black. *Rhizines* not well developed. *Apothecia* not seen. *Pycnidia* hyaline, glob-



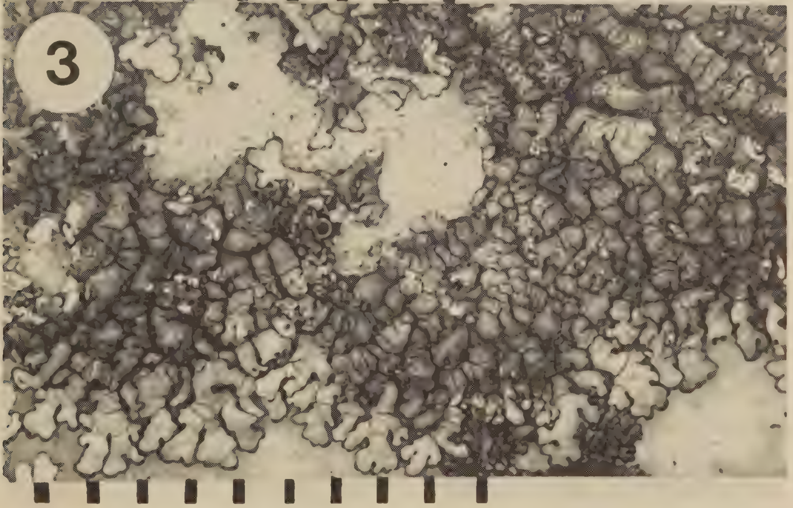


FIGURE 2. - *Parmelia dwaasbergensis* Brusse, habit. *F. Brusse 5211*, holotype. Scale in mm.

FIGURE 3. - *Parmelia inops* Brusse, habit. *F. Brusse 5212*, holotype. Scale in mm.

ose, 110 - 150 µm deep, 90 - 110 µm wide. *Pycnidiospores* hyaline needles, 6 - 9 X 0,8 µm. *Chemistry:* usnic acid in the cortex, hypostictic, hyposalazinic and hypoconstictic acids in the medulla.

This is a unique new species, probably belonging to the *Parmelia adhaerens* Nyl. group. This is the first species of this group known to be isidiate. Like *P. adhaerens*, *P. lyrigera* contains hypostictic acid in the medulla, but lacks the stictic acid of *P. adhaerens*, and contains hyposalazinic acid instead.

Without close inspection, this new lichen resembles the widespread (in the eastern half of the country) *P. adligans* Brusse (1988b), which this lichen was at first presumed to be. However, *P. adligans* contains atranorin as well as usnic acid in the upper cortex, contains only the stictic acid complex in the medulla, and most of all lacks isidia.

Parmelia tantillum Brusse (syn. *Xanthoparmelia inconspicua* Hale, 1987) is not really the non-isidiate progenitor of this species, for although small, it is genuinely foliose, has a glossy upper surface, and small, true rhizines below.

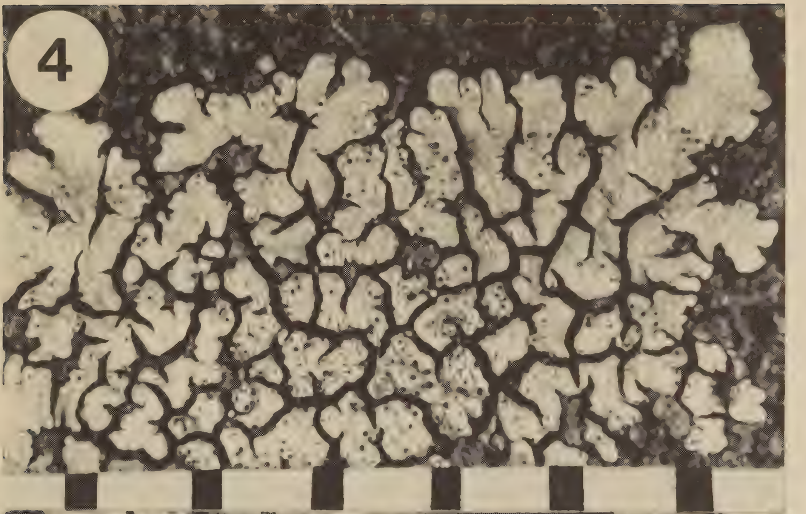
The rock type from which this new lichen was collected is restricted to small areas of the south-eastern Transvaal and adjacent Swaziland, and is a fine grained, dark grey, basic igneous rock, belonging to the Ususwhana complex. However, it would be surprising if this species were restricted to this rock type.

At present, this new species is known only from the type locality, in the hills just east of Amsterdam, in the south-eastern Transvaal.

PARMELIA SITIENS Brusse, *sp. nov.* Fig. 5

Thallus minute foliosus, saxicola, ad 2 cm diametro, arcte adnatus. *Lobi* elongati, truncati, 0,2 - 1,0 mm lati, 95 - 200 µm crassi. *Thallus superne* cinereus, nitidus, emaculatus, isidiis sorediisque destitutus. *Cortex superior* 13 - 16 µm crassus. *Stratum gonidiale* 20 - 45 µm crassum, algis *Trebouxiis*, 4 - 18 µm diametris. *Medulla* alba, 45 - 120 µm crassa. *Cortex inferior* 10 - 14 µm crassus. *Thallus inferne* piceus, sat rhizinatus. *Rhizinae* simplices, 45 - 140 µm crassae. *Apothecia et pycnidia* non visa. *Thallus* atranorinum, acidum salazinicum et materiam ignotam continens.

TYPUS: SOUTH AFRICA, CAPE PROVINCE - 3319 (Worcester): W side of Franschhoek Pass, overlooking the town of Franschhoek, above hairpin bend and just below summit of Pass.



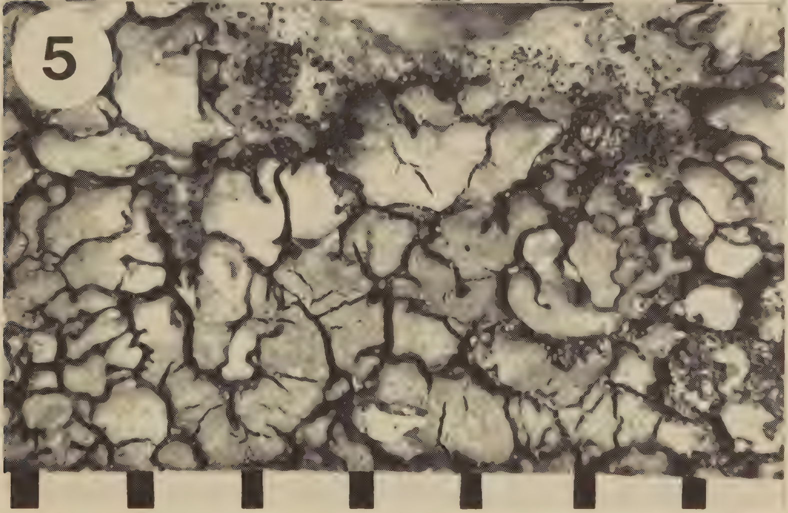


FIGURE 4. - *Parmelia lyrigera* Brusse, habit. *F. Brusse 5564*, holotype. Scale in mm.

FIGURE 5. - *Parmelia sitiens* Brusse, habit. *F. Brusse 5437*, holotype. Scale in mm.

Large Table Mountain Sandstone outcrop on steep W slope. On sloped N face at base of outcrop. Alt. 730 m (-CC). *F. Brusse 5437*, 20. iii. 1988 (PRE, holo-; BM, iso-). Figura 5.

Thallus minutely foliose, saxicolous, to 2 cm across, tightly adnate. *Lobes* elongate, truncate, 0,2 - 1,0 mm broad, 95 - 200 µm thick. *Upper surface* grey, glossy, emaculate, non-isidiate and non-sorediate. *Upper cortex* 13 - 16 µm thick. *Algal layer* 20 - 45 µm thick, algae *Trebouxia*, 4 - 18 µm diam. *Medulla* white, 45 - 120 µm thick. *Lower cortex* 10 - 14 µm thick. *Lower surface* black, moderately rhizinate. *Rhizines* simple, 45 - 140 µm thick. *Apothecia and pycnidia* not seen. *Chemistry:* atranorin, salazinic acid and the "chalybaeizans unknown" present.

Parmelia sitiens is the second *Paraparmelia* known to contain salazinic acid and the "chalybaeizans unknown" in the medulla, the first being the common *P. condyloides* Kurok. (Hale 1972, 1976). *P. sitiens* is a much smaller lichen than *P. condyloides*, and also has a black rather than a pale lower surface. The under surface colour of *P. condyloides* is quite variable, and can become sooty black in some places on certain specimens. Judicious selection of such material, can produce specimens that look homogeneously black below, but further collections at the locality of origin will reveal the variation again. Nevertheless, the normal colour for the under surface of *P. condyloides* is pale brown.

Parmelia pudens Brusse (1986) is another small *Paraparmelia* with a black lower surface which contains salazinic acid, but this lichen lacks the "chalybaeizans unknown" and has smaller discrete sublinear to linear lobes. *P. sitiens* has broader, truncate, elongate lobes that are contiguous, not discrete.

At present, this new species is known only from the type locality, just east of the town of Franschhoek, in the south-western Cape Province.

NEW COMBINATIONS

Brusse (1988b, 1989) has made new combinations in *Parmelia* for lichens previously assigned to *Paraparmelia* and *Xanthoparmelia*, by other authors, notably Hale and Elix, for reasons explained by Brusse (1988a). A proposal, 291A (McNeill 1986), which would have rendered all lectotypifications proposed before 1935 void, has not been passed by the Berlin International Botanical Congress (Greuter & McNeill 1987, McNeill 1987). This leaves the first typification of *Parmelia* as *Parmelia conspersa* Ach. (Clements & Shear 1931), and the arguments presented by Brusse (1988a) unchanged.

The following new combinations in *Parmelia* are proposed:

Parmelia evernica (Hale) Brusse, *comb. nov.*
Basionym: *Xanthoparmelia evernica* Hale, *Mycotaxon* 27: 577, 1986.

Parmelia rubropustulata (Hale) Brusse, *comb. nov.*
Basionym: *Xanthoparmelia rubropustulata* Hale, *Mycotaxon* 29: 264, 1987.

NEW LICHEN RECORDS

Parmelia (Parmotrema) araucariarum Zahlbr.

SWAZILAND - 2631 (Mbabane): Mbabane district. 10 km from Ezulweni to Commissie Nek, near nJinjane Kraal. Kloof forest patch on SE slope, near mountain summit. On vertical face of granite boulder, in complete shade. Alt. 990m (-AC). *F. Brusse 4304*, 25. xii. 1985 (BM, LD, PRE, US).

This material is not quite identical to the holotype (W), but one of the pigments is the same as in both pieces of the holotype. A series of aliphatic acids are present in the above material in high concentrations, some of which seem the same as in the holotype (as judged by TLC in three solvent systems). This difference is probably chemosyndromic, and is probably not taxonomically significant.

Porpidia (Poeltiaria) turgescens (Koerb.) Brusse

SOUTH AFRICA, CAPE PROVINCE - 3226 (Fort Beaufort): Katberg Pass between Fort Beaufort and Queenstown. Main Katberg Forest, steep SW slope of Branderskop, at Rest Spot. On SW face of Beaufort mudstone boulder near stream, in deep forest shade. Alt. 1100 m (-BC). *F. Brusse 5143*, 3. iii. 1988 (BM, COLO, LD, PRE).

This material is unusual in that it lacks confluentic and 2'-O-methylperlatolic acids. In fact, no substances were detected by TLC. However, there seems to be no significant morphological differences between this material and the available descriptions of *P. turgescens* (Hertel 1984), although I have not examined any authentic material.

NOTES ON SOME PARMELIACEAE

Parmelia astricta Brusse, *Bothalia* 15: 315, 1984.
Synonyms: *Paraparmelia astricta* (Brusse) Elix & Jen Johnston, *Mycotaxon* 27: 279, 1986.
Paraparmelia olivetorica Nash & Elix, *Mycotaxon* 29: 468, 1987.

Dr Elix has kindly sent me a fragment of *Parmotrema demethylmicrophyllinicum* Elix as an authentic source of 4-O-demethylmicrophyllinic acid. This was run on TLC plates together with alectoronic acid and an acetone extract of *Parmelia astricta*, and although running close together on all three plates, 4-O-demethylmicrophyllinic acid has a pale pinkish colour, whereas alectoronic acid is completely colourless. This indicated that *P. astricta* does not contain alectoronic acid as originally stated, but 4-O-demethylmicrophyllinic acid. This renders *Paraparmelia olivetorica* Nash & Elix, a synonym of *Parmelia astricta* Brusse.

Parmelia astricta is a common lichen in the southern and south-western Cape Province, and the following are additional localities for this species, over and above Bain's Kloof and those cited by Brusse (1988b):

SOUTH AFRICA, CAPE PROVINCE - 3318 (Cape Town): Cape Town, south side of summit of Table Mountain. On vertical SW face of Table Mountain Sandstone outcrop on SW slope. Alt. 1040 m (-CD). *F. Brusse 5415*, 18. iii. 1988 (BM, PRE). 3319 (Worcester): Summit of Jona's Kop in the Riviersonderend Mountains near Villiersdorp. On low Table Mountain Sandstone outcrop in rock shade, on N slope. Alt. 1620 m (-DC). *F. Brusse 5464*, 21. iii. 1988 (BM, PRE). 3320 (Montagu): 7 km S of winery at Barrydale, Tradouw Pass, on Table Mountain Sandstone cliffs with overall S aspect, but on sloped portion with W aspect. Alt. 300 m (-DC). *F. Brusse 5343*, 14. iii. 1988 (BM, PRE). 3419 (Caledon): Summit of Galgeberg near Greyton (but accessed via McGregor), farm Galge Berg. On S face of Table Mountain Sandstone cliff on steep S slope. Alt. 1410 m (-BA). *F. Brusse 5488*, 22. iii. 1988 (BM, COLO, LD, PRE).

Parmelia burmeisteri Elix, *Austral. J. Bot.* 24: 664, 1976.
Synonym: *Xanthoparmelia burmeisteri* (Elix) Egan, *Bryologist* 85: 129, 1982.

An interesting extension of the southern African range of this species, *c.f.* Brusse (1988b), is provided by the following specimen:

SOUTH AFRICA, CAPE PROVINCE - 3219 (Wuppertal): 5 km NW of Wupperthal. Small hill just N of Kouberg settlement. On

TMS on S to W slopes. Alt. 900 m (-AC). *F. Brusse 3197*, 4. v. 1981 (PRE).

Parmelia fausta Brusse, *Mycotaxon* 27: 185, 1986.

The range of this lichen, which was previously only known from the summit of Swartberg Pass near the Cango Caves and Oudtshoorn (the type locality), has been significantly increased by the following specimens:

SOUTH AFRICA, CAPE PROVINCE - 3318 (Cape Town): Cape Town, south side of summit of Table Mountain, SSW slope overlooking Hely-Hutchinson Reservoir. On S side of Table Mountain Sandstone outcrop. Alt. 950 m (-CD). *F. Brusse 5423*, 19. iii. 1988 (BM, PRE, UPS). 3319 (Worcester): Hawequa's Mountains, east of Paarl, near TV tower. On NW Table Mountain Sandstone cliffs on almost vertical slope. Alt. 1070 m (-CA). *F. Brusse 5405*, 17. iii. 1988 (BM, LD, PRE). Summit of Jona's Kop in the Riviersonderend Mountains near Villiersdorp. On Table Mountain Sandstone outcrop in rock shade on N slope. Alt. 1620 m (-DC). *F. Brusse 5464b*, 21. iii. 1988 (BM, PRE).

Parmelia mongaensis Elix, *Austral. J. Bot.* 29: 22, 1981.
Synonyms: *Paraparmelia mongaensis* (Elix) Elix & Jen Johnston, *Mycotaxon* 27: 280, 1986.
Parmelia insignis Brusse, *Mycotaxon* 27: 186, 1986.

Since the last note on *Parmelia insignis* (Brusse 1988b) I have been able to examine an Australian specimen of *P. mongaensis*, through the generosity of Dr J. A. Elix (Canberra). Although ascospores were again not found, despite the presence of small apothecia, the general appearances of the lichens and the chemistries are identical, so that I have no hesitation in synonomizing *P. insignis* with *P. mongaensis*. The "insig-1" of the original publication is stenosporonic acid and the "insig-2" is colensoic acid. Divaronic acid also occurs in this species in minor quantities as well as one or two substances in the physodic acid series, but these latter substances often occur only as traces.

The synonym *Parmelia insignis* Brusse is, in fact, the first record of *P. mongaensis* Elix from southern Africa (and the African continent), and not the specimen reported to have been collected from Magoeba's Kloof, cited by Nash and Elix (1987).

The southern African range of this lichen has been extended almost to Cape Town by the following specimens:

SOUTH AFRICA, CAPE PROVINCE - 3319 (Worcester): Hawequa's Mountains, east of Paarl. Hugenootskop. On low Table Mountain Sandstone pavedment, on fairly gentle E slope. Lines the mouths of rock pockets here. Alt. 1070 m (-CA). *F. Brusse 5411*, 17. iii. 1988 (BM, COLO, PRE). 3324 (Steytlerville): Suuranysberg Range. 7,5 km from the Krom River bridge at Assegaaibos near Kareedouw to the Upper Kouga River Basin area. On S face at base of Table Mountain Sandstone outcrop on steep W slope. Alt. 600 m (-CD). *F. Brusse 5190*, 7. iii. 1988 (BM, COLO, LD, PRE, UC, UPS).

Parmelia nimbicola Brusse, *Mycotaxon* 27: 238, 1986.

This rare lichen has now been found further west in the Langeberg at Garcia's Pass near Riversdale. It was origially only known from the very eastern end of the Langeberg Range (actually the very western end of the succeeding mountain range, the Outeniqua Mountains) at Robinson's Pass.

SOUTH AFRICA, CAPE PROVINCE - 3321 (Ladismith): 17 km N of Riverdale, Garcia's Pass. SW slopes of Kareekop, Langeberg Range. On Table Mountain Sandstone outcrops on steep S slope. Alt. 500 m (-CC). *F. Brusse 5338*, 14. iii. 1988 (BM, PRE).

Parmelia princeps Brusse, *Bothalia* 17: 27, 1987.

The type locality of this lichen was thoroughly examined for more material, in an effort to clarify the status of this name, since the type material is rather scanty and mixed with *Parmelia squamariata* Nyl. or a very similar species. However, I was unable to find a brown *Parmelia* with a chemistry identical to the original material, but did find material containing "squamatic acid". This determination is erroneous, but the uppermost substance (which fluoresces white under longwave ultra-violet light) on plate B, seems identical to one of the substances in *Parmelia thamnolica* (Hale) Brusse, which does contain squamatic acid. Three other substances are present, but do not correspond on TLC plates to any of the other substances in *P. thamnolica* or to thamnolic and decarboxythamnolic acids. The new material of *P. princeps* has lobes with scabrous upper surfaces up to 1 mm broad and apothecia up to 1,5 mm broad. The lichen appears to be related to *P. trachythallina* Essl.

Besides the type locality at Witelskloof near Clanwilliam, this lichen has also been found at Nuwekloof near Tulbagh:

SOUTH AFRICA, CAPE PROVINCE - 3218 (Clanwilliam): 8 km W of Olyvenboskraal, Witelskloof. Farm Groot Alexanders Hoek, near Klein Alexandershoek farm house. On slightly sloping top of large Table Mountain Sandstone boulder outcrop, just W of Koperfonteinkloof stream. Alt. 500 m (-BD). *F. Brusse 5538*, 25. iii. 1988 (BM, LD, PRE). 3319 (Worcester): 7 km W of Tulbagh, Nuwekloof in the Obiqua Mountains. On SE side of Table Mountain Sandstone rock, on steep SW slope. Alt. 140 m (-AC). *F. Brusse 5499a*, 22. iii. 1988 (PRE).

Parmelia sigillata Brusse, *Mycotaxon* 31: 537, 1988.

The chemistry of this lichen was inadvertantly omitted from the original publication and the final sentence of the Latin description should read: *Thallus* acidum usnicum, acidum evernicum et acidum lecanoricum continens. (Instead of being omitted). Similarly the final sentence of the English description that follows should read: *Chemistry:* usnic acid in the cortex, evernic and lecanoric acids in the medulla. (Instead of being omitted).

ACKNOWLEDGEMENTS

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GANODERMA MICROSPORUM, A NEW SPECIES ON WEEPING WILLOW IN TAIWAN

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SUMMARY

This report discribes a rare fungus found on the dead trunk of a weeping willow (Salix babylonica Linn.) in Taipei. The fungus can be assigned to the genus Ganoderma, but differs from other common species in color and shape, and in the small size of the basidiospores. Monokaryons from isolates of the fungus were cultured and mated with monokaryons from other species in Taiwan, but none of the matings yielded fruiting bodies. Because the fungus differs substantially from other known species, it is described as new.

INTRODUCTION

The genus Ganoderma was established by Karsten (1881) with G. lucidum (W.Curt.:Fr) Karst. as the only species. Murrill in his published synopses (1902, 1908) considered primary taxonomic characters to be host specificity, geographical distribution, and macromorphology of the fruiting body which included context color, the shape of the margin of the pileus, and whether the fruiting body was stipitate or sessile. Haddow(1931) and Steyaert(1972-80) based their taxonomy on basidiospore characteristics and morphology of cutis hyphal elements of the fruiting body.

The first recording of Ganoderma species in Taiwan was by Sawada(1931, 1942), in which 6 species were included. Chang and Chen(1984) recorded a new species Ganoderma formosanum (host: Liquidambar formosana).

In 1983 a fruiting body was found in Taipei on the dead trunk of Salix babylonica Linn. The purpose of this paper is to prove that this is a new species. The research used the above mentioned taxonomic characters to establish this.

Ganoderma microsporum Hseu, sp. nov.

Basidioma annuum, sessilis et dimidiatum vel plerumque stipitatum, flabelliformis vel conchatum, pleuropum, pileis sejunctis interdum crescentibus, suberosis vel ligneis, usque ad 6 cm diametro et 2-2.5 cm crasso. Pilei pagina radialiter rugosa, concentrice undulata, niger, gradatim argillacea vel isabellina marginem versus; specimina juniores cremea vel eburnea, matura nigricantia et splendide laccata. Margo sterilis, obtusus, undulatus vel rectus. Stipes brevis, crassus, niger, laccatus, cylindricus, 0.5-2 X 1-1.5 cm, basi crassior aliquantus. Pagina porifera brunnea, strato tubifero usque ad 1.2 cm crasso. Pori in speciminibus juvenibus parvi, circulares, cremei, in maturis flavi neapolitani vel bubalini, 160-210 um diametro, 4-6 in omnibus millimetris, dissepimenti (40)65-165 um. Contextus 0.2-1.2 cm crassus bubalinus vel subroseus in parte superiore, in zona super tubis cinnamomeus vel brunneus. Dermis e cellulis crassis, aureis, claviformibus composita; hae cellulae ex extremitatibus hypharum skeletalium enata, 5-10 X 87.5-100 um, luminibus angustatis extremitatibus obtusis, in hymenio dispositae, strato crasso laccato obtecto. Systema hypharum trimiticum. Hyphae generatoriae hyalinae 1-2.5 um diametro, parce ramosae; parietibus tenuibus, septis non nisi in fibulis; in marginem pilei abundantes, in contextu et in dissepimentis aliquot. Hyphae skeletalia non septatae, 1-3 diametro, crassitunicatae, contextus et dissepimentorum partem majorem faciens. Hyphae colligantes quam hyphae skeletalia tenuior, crassitunicatae, non septatae, copiose ramosae, 0.3-1 um diametro. Basidia breviter clavata vel subglobosa, 7-11 X 11-19 um, sporis quatuor. Basidiosporae ovoideae vel subsphaeriacae, pariete bistrato cyanophilo; perisporium hyalinum tenue, endosporium aureum, crassum, echinulatum; basidiosporae maturae 4.5-5 X 6-8 um.

Fruitbody: annual, sessile, dimidiate, or more frequently, stiptitate to flabelliform to conchate, pleuropus with isolated pilei which are sometimes concrescent, corky to woody, up to 6 cm diam and 2.0-2.5 cm thick.

Pileus: surface radially rugose, which concentric, slightly raised sulcations making it appear undulated, aniline black or raisin black, gradually becoming clay color or isabelline towards the margin; young specimens cream or ivory-yellow color, this gradation in color not seen in mature specimens, the color tending to become homogeneous aniline black or raisin black and brilliantly laccate. Margin sterile, blunt, undulate or even.

Stem: Horizontal, short and thick, aniline black or raisin black, laccate, cylindric, 0.5-2.0 cm long, 1-1.5 cm thick, somewhat thicker at the base.

Context: 0.2-1.2 cm thick, cartridge buff or pale pinkish is the upper part, cinnamon buff or sayal brown in the zone above the tubes. Dermis composed of thick, golden-walled claviform elements originating from the end of skeletal hyphae, with narrow limina and blunt ends, 5-10 X 87.5-100 um, arranged in a palisade-like hymenium, covered with a thick layer of lacquer-like substance.

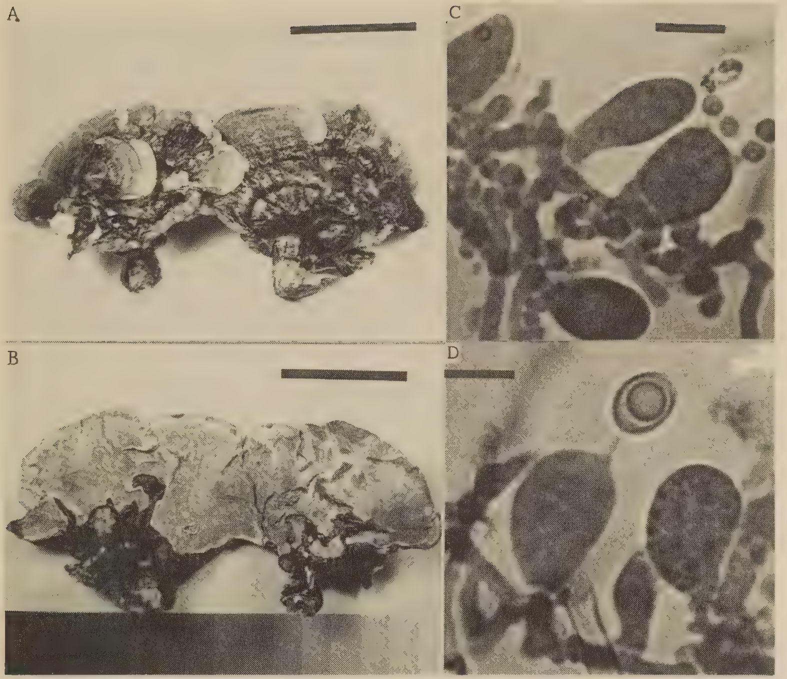

Figure 1. *Ganoderma microsporum* (TAI9021, holotype).
A-B. Basidiocarps of *Ganoderma microsporum*.
The bar in each figure = 4 cm.
C-D. Brightfield microscopy of basidia of *Ganoderma microsporum*. The bar in each figure = 5 um.

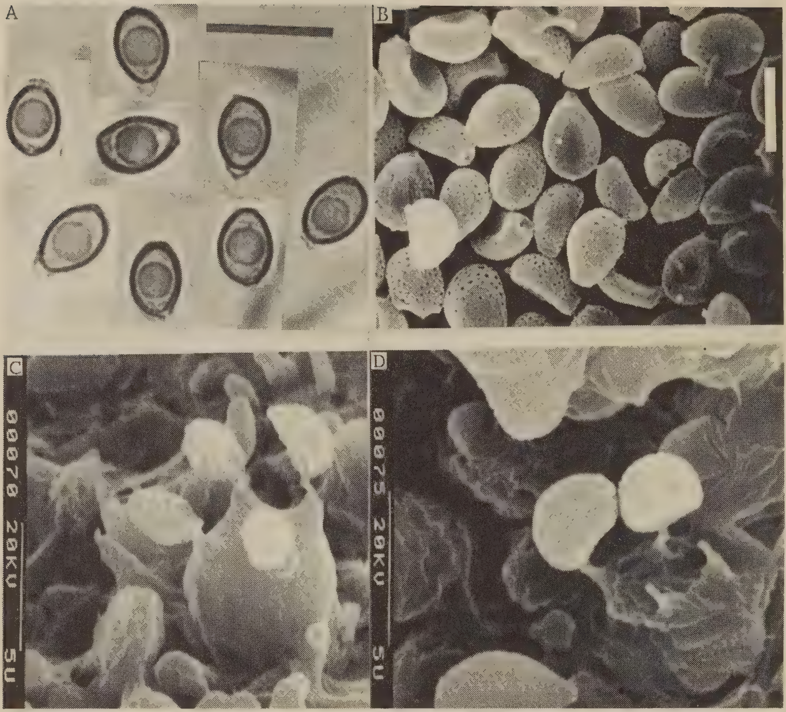
A
B
C
00070 20KU 5U
D
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Figure 2. *Ganoderma microsporum* (TAI9021, holotype).

A. Brightfield microscopy of basidiospores.
The bar in figure = 10 um.

B. Scanning electron microscopy of basidiospores.
The bar in figure = 5 um.

C–D. Scanning electron microscopy of basidia and basidiospores.

Pore surface: verona brown or chestnut brown, with the tube layer up to 1.2 cm deep. Pores small, circular, cream colored in young specimens, and naples yellow or colonial buff in mature ones, 160-210 um diam, dissepiments (40)65-165 um, 4-6 per mm.

Basidia: short clavate to subglobose, 4-spored, 7-11 X 11-19 um.

Basidiospores: ovoid to subspherical, with two-layered cyanophilous wall; perisporium hyaline, thin; endosporium golden-yellow, thick; endosporic echinula numerous, slender; mature sproes 4.5-5.0 X 6-8 um.

Hyphal system: trimitic. Generative hyphae clamped, thin-walled hyaline, with septa restricted to clamps, sparingly branched, 1-2.5 um diam; abundant at the margin of the plieus but also present in the context and dissepiments. Skeletal hyphae aseptate, thick-walled, 1-3 um in diam, forming the bulk of the context and dissepiments. Binding hyphae thinner than the skeletals, thick-walled, aseptate, abundantly branched, 0.3-1 um in diam.

Habitat: On dead trunk of Salix babylonica Linn.

Specimens examined: Taipei, 21 August 1983. TAI 9021, Holotype.

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中文摘要

許氏小孢子靈芝（ *Ganoderma microsporum* Hseu, sp. nov. ）爲在台北地區所發現的新種眞菌。此種的特徵在於其擔孢子較一般靈芝屬的擔孢子爲小，僅4.5－5.0×6－8 μm，而子實體形態與菌蓋顏色也與其他種類不同，且其寄主爲垂柳（ *Salix babylonica* Linn.）。並由單孢系菌株間的交配試驗結果顯示與台灣其他種類的靈芝皆具不親和性反應。故作者以新種命名之。

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A NEW LICHEN GENUS, PSILOPARMELIA HALE (ASCOMYCOTINA: PARMELIACEAE)

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Abstract: A new lichen genus *Psiloparmelia* is proposed. It is based on *Parmelia distincta* Nyl. (*Psiloparmelia distincta* (Nyl.) Hale, comb. nov.) from the high Andes Mountains. A second species, *P. arhizinosa* Hale, sp. nov., has been discovered in Lesotho. The genus is characterized by a velvety lower surface without rhizines, a negative test for lichenin, and a high concentration of usnic acid and atranorin in the cortex.

Introduction

When I proposed the genus *Xanthoparmelia* (Hale, 1974), I included in it five well-known arctic species, *P. aleuritica* Nyl., *P. centrifuga* (L.) Ach., *P. incurva* (Pers.) Ach., *P. separata* Th. Fr., and *P. subcentrifuga* Oxner. Later (Hale, 1986a), I realized that these species formed a heterogeneous element and erected the new genus *Arctoparmelia* to accommodate them. The main characters used to delimit *Arctoparmelia* were constant presence of alectoronic acid in the medulla (only one of 406 species of *Xanthoparmelia* contains alectoronic acid as the main medullary component), high concentrations of atranorin and usnic acid in the cortex (usnic lacking only in *A. aleuritica*), a strong iodine test for lichenin, a negative test with Melzer's reagent, and a peculiar ivory-white to purplish black velvety lower surface. *Xanthoparmelia* rarely has atranorin and then only as traces, is positive for both lichenin and Melzer's reagent (unpublished data, Ralph Common), and has a smooth, shiny lower surface.

I had also placed *Parmelia distincta* Nyl. (Hale, 1974) in *Xanthoparmelia*. Although this well-known species is superficially very similar to *Arctoparmelia* in lobe configuration, cortical chemistry, and presence of a velvety lower surface, I had hesitated to put it in that genus for several reasons. It occurs at very high elevations in the Andes Mountains of South America, not in the arctic, and is therefore completely allopatric. While it has a velvety lower surface (Fig. 1), rhizines are totally lacking (as noted by Nylander in the original description). One of the major metabolites, fumarprotocetraric acid, is biogenetically unrelated to alectoronic acid and occurs in the cortex, not the medulla. Most significantly, it has a negative iodine test for lichenin (Ralph Common, unpublished data). While a negative lichenin test would suggest a relationship with *Pseudoparmelia* Lynge, my recent delimitation of this genus (Hale, 1986b) would exclude *P. distincta* on the basis of chemical and lower surface characteristics. *Pseudoparmelia* has a smooth rhizinate lower surface and an unknown yellowish medullary pigment.

I recently collected another species closely related to *X. distincta* in Lesotho, adding to my conviction that the two of them are distinct from both *Arctoparmelia* and *Xanthoparmelia*. With our better knowledge of generic limits in the Parmeliaceae, I believe that these erhizinate species should be recognized as a new genus, *Psiloparmelia*. The differences between these genera are summarized in the chart below:

	Xanthoparmelia	*Arctoparmelia*	*Psiloparmelia*
Cortical Substances	Usnic acid atranorin (±trace)	Usnic acid* atranorin**	Usnic acid atranorin** and fumarprotocetraric acid (±)
Lichenin	Positive	Positive	Negative
Melzer's Reagent	Positive	Negative	Negative
Lower Surface	Smooth, shiny	Velvety	Velvety
Rhizines	Present***	Present	Lacking
Geography	Cosmopolitan	Arctic	Southern Hemisphere

*Lacking in *A. aleuritica*
**Present in high concentration
***Lacking in 6 of 406 species

Psiloparmelia, gen. nov.

Parmelia sect. *Xanthoparmelia* subsect. *Endocoerulea* Gyel. Type species of subsection: *Parmelia bouly de lesdainii* [*"lesdaini"*] Gyel. 1931:282.

Thallus foliaceus, adnatus, saxicola, lobis sublineàribus, superne epicorticatus, pruinosus, subtus minute papillatus, erhizinosus. Pycnidia immersa, conidiis bifusiformibus. Apothecia substipitata, sporis incoloribus, simplicibus.

Type species: *Parmelia distincta* Nyl.

Psiloparmelia distincta (Nyl.) Hale, comb. nov.

Parmelia distincta Nyl., 1861:374. Type collection: Prov. Yungas, Bolivia, *Weddell* s.n. (H-Nyl, Nyl. Herb. No. 34819, lectotype).

Parmelia subcongruens Müll. Arg., 1889:64. Type collection: Argentina, *Lorentz & Hieronymus* s.n. (M, lectotype; G, W, isolectotypes).

Parmelia flavobrunnea Müll. Arg., 1891:379. Type collection: Azangaro, Peru, *Lechler* 1766 (BM, lectotype; G, isolectotype).

Parmelia bouly de lesdainii Gyel., 1931:281. Type collection: Hacienda d'Angasmurca, 160 km from Trujillo, Libertad, Peru, *Standaert* s.n.(BP, lectotype).

Parmelia subcongruens var. *bouly de lesdainii* (Gyel.) Gyel., 1935:21.

Parmelia distincta f. *bouly de lesdainii* (Gyel.) Gyel., 1938:26.

Parmelia distincta f. *subcongruens* (Müll. Arg.) Gyel., 1938:26.

Xanthoparmelia distincta (Nyl.) Hale, 1974:487.

Xanthoparmelia flavobrunnea (Müll. Arg.) Hale, 1974:487.

Thallus (Fig. 3) adnate to loosely adnate, leathery, 5–10 cm in diameter, light yellowish green; lobes subirregular to sublinear, irregularly branched, 0.8–3 mm wide, imbricate; upper surface dull, emaculate, becoming coarsely white pruinose with age, transversely cracked and rugulose at the center, isidia and soredia lacking; medulla white or darkening somewhat, dense and waxy in texture; lower surface plane, dull, velvety, yellowish grey at the margins but turning jet black toward the center, rhizines lacking. Pycnidia immersed, commonly produced; conidia bifusiform, $0.5 \times 5-6$ μm. Apothecia adnate to substipitate, 2–5 mm in diameter; spores subspherical to elliptical, $6-9 \times 10-12$ μm.

Chemistry: Usnic acid, atranorin, and fumarprotocetraric acid (minor) in the cortex (P+ red), protoconstipatic acid (major), constipatic acid, protocetraric acid (±trace), and ursolic acid (trace) (annotations by J. A. Elix in H-Nyl for the lectotype specimen).

Additional representative specimens examined. ECUADOR. Prov. El Altar: *Meyer* 383 (W). Prov. Chimborazo: 10 km W of San Juan, *King* 74-40, 74-67 (US). Prov. Cotopaxi: Parque Nacional Cotopaxi, *Harris* 17386 (NY). Prov. Tungurahua: Riobamba, *Iltis* E-488 (US). PERU. Prov. Recuay: Huaraz, *Armstrong* 168, 172 (PH); Colltu, *Gomez* 542 (US). Dept. Puno: Chucuito, *Thomasson* s.n.

(UPS). Dept. Junin: Tarma, *Killip & Smith* 21874 (F). Aequipa, *Stafford* s.n. (BM). Chaira, *Wood* s.n. (US). Rio Blanco, *Bryan* 93, 136 (F). BOLIVIA. Bolivia, Andes, *Mandon* s.n. (H-Nyl, Nyl. Herb. No. 34818, 34820, isosyntypes of *P. distincta*). Prov. Larecaja: Challana, *Mandon* 1760 (W). Prov. Manco: Puna, *Feuerer* 15522 (HBG). Prov. Murillo: Zongotal, *Feuerer* s.n. (HBG, US).Lake Titicaca, Capacabana, *Suarez* 7 (US). ARGENTINA. Prov. Catamarca: Las Rosas, *Lamb* 5765 (FH, US).

Nylander's herbarium contains three collections from Bolivia. Gyel. (1938:25) apparently saw only one of these (no. 34819) and designated it as the type of *P. distincta*. I see no reason not to follow his lectotypification. Gyel. (1931) also used *P. bouly de lesdainii* as the type for his *Parmelia* sect. *Xanthoparmelia* subsect. *Endocoerulea* Gyel. The description of the subsection, "medulla thalli coerulea," seems to be based on the waxy, sometimes darkening medulla in some specimens. He later (1935) amended the subsection to read "erhizinosus."

This is perhaps the most commonly collected foliose lichen at high elevation in the Andes Mountains from Ecuador south to Bolivia and into northern Argentina. The chemistry is unusual in that fumarprotocetraric acid appears to be confined to the cortex, which reacts P+ orange, the medulla reacting P−. However, about half of the specimens tested react P− in the cortex and contain only the fatty acids. The types of *Parmelia distincta* (nos. 34819 and 34820) and *P. subcongruens* react P+ red; the third syntype of *P. distincta* (no. 34818) and the type of *P. flavobrunnea* are P−. I have not rechecked the P test for *P. bouly de lesdainii*.

Psiloparmelia arhizinosa Hale, sp. nov.

Thallus adnatus, saxicola, 3–7 cm latus, albo-flavicans, lobis subirregularibus, 0.8–2 mm latis, subimbricatis, superne continuus, emaculatus, albopruinosus, cortice epicorticato, aetate rugulosus, pustulato-sorediatus, soraliis capitatis, ad 1 mm diametro, sorediis crassis, subtus planus, pallide griseo-brunneus, erhizinosus. Pycnidia atque apothecia desunt.

Thallus (Fig. 4) tightly adnate to adnate on rock, 3–7 cm broad, pale whitish yellow-green; lobes subirregular, 0.8–2 mm wide, irregularly dichotomously branched, subimbricate; upper surface continuous, dull, emaculate, faintly to strongly white pruinose, rugulose with age, sparsely to moderately grossly pustulate, the pustules erupting into coarsely sorediate masses up to 1 mm in diameter; medulla white; lower surface plane, finely felty-velvety, dull, brown to dull mineral gray at the center, pale to ivory-colored at the tips, rhizines lacking. Pycnidia and apothecia lacking.

Chemistry: Atranorin and usnic acid in the cortex, protoconstipatic acid and constipatic acid in the medulla.

Type: Dolerite ledges 16.6 km NW of Sani Pass at the west side of Kotisephola Pass (on road to Moteng Pass), elev. 3100 m, Lesotho, Grid 2929 AC, *M. E. Hale* 81411, 5 May 1988 (US, holotype; LD, PRE, isotypes).

Additional specimens examined. Lesotho: Same locality as the holotype, *Hale* 81434 (US); 56.1 km NW of Mapholaneng (ca 26 km N of Letsengla-Terai), on Moteng Pass road, *Hale* 81438, 81439, 81440 (US)

This unusual species occurs in high elevation alpine habitats (3000–3300 m) in Lesotho, usually on the sheltered lower sides of dolerite ledges which receive little if any direct rainfall. It has a peculiar grayish velvety lower surface (Fig. 2) (*P. distincta* is black) without rhizines, a rugose, pruinose surface, and coarse soralia (*P. distincta* is esorediate). It contains high concentrations of atranorin in the cortex along with usnic acid, just as in *P. distincta* and *Arctoparmelia* species in general. Finally, it has the same negative lichenin test as *P. distincta* (Ralph Common, personal communication) and the same fatty acid chemistry but without fumarprotocetraric acid.

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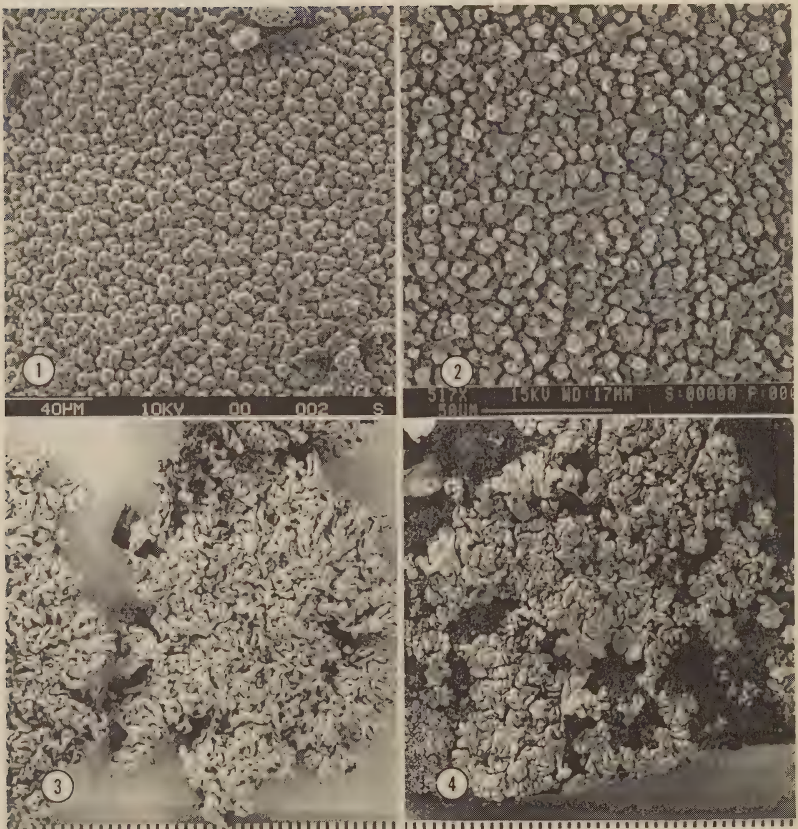

Figures 1–4. Species of *Psiloparmelia*: 1, lower surface of *P. distincta* (SEM) (*King* 74-40); 2, lower surface of *P. arhizinosa* (SEM) (*Hale* 81440); specimen of *P. distincta* (*Killip & Smith* 21874) (scale in mm); 4, holotype specimen of *P. arhizinosa* (*Hale* 81411) (scale in mm).

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QUELQUES RUSSULES A LAMPROCYSTIDES

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INTRODUCTION

Suite à la découverte d'une nouvelle *Russula* à lamprocystides, dont la description est présentée ici, les caractères microscopiques de *R. guayarensis* Singer sont décrits et illustrés en détail. Cette espèce bolivienne représente à elle seule la sous-section *Guayarenses* Singer que Singer range parmi les *Pelliculariae* Heim ex Singer et qu'il définie (1983 : 205) par les cystides hyméniales à paroi épaisse et par la structure du type 'virescens' du revêtement piléique reposant sur un subpellis gélifié.

Les exsiccata ont été traités par une solution aqueuse (ca. 20%) de KOH pour faciliter la dissociation et le regonflement des tissus, dont l'étude s'est effectuée à partir de préparations semi-permanentes dans le rouge Congo ammonical additionné de 10% de glycérine. Dans les descriptions qui suivent, les dimensions sporales, basées sur vingt spores, donnent la longueur et la largeur moyennes, accompagnées de leur écart type (standard deviation): suit encore, entre parenthèses, le rapport moyen de la longueur sur la largeur.

Nous donnons d'abord les descriptions des deux espèces et, ensuite, la présence de lamprocystides dans le genre *Russula* sera discutée.

RUSSULA GUAYARENSIS Singer, Beih. Nova Hedw. 7 : 205-206 (1983).

Caractères microscopiques - Fig. 1-3.

Spores subglobuleuses à brièvement ellipsoïdes, 7,63 ± 1,47 x 7,02 ± 1,08 µm (Q = 1,09), ornées de crêtes hautes et de quelques longues épines aiguës, fortement ou partiellement amyloïdes, parfois reliées par de brefs tractus, plus souvent cristulées-caténulées, formant un réseau quasiment complet; plage non à faiblement amyloïde, verruqueuse au bord. **Basides** (42-)45-55 x 12-14(-16) µm, légèrement clavées, tétrasporiques, à contenu finement granulé; stérigmates aigus; basidioles clavulées. **Cystides** assez abondantes sur les faces, (50)-65-75 x 8-13(-16) µm, subfusiformes, clavulées, souvent mucronées de façon peu apparente parce que vite flétries, à contenu peu abondant, pailleté-granuleux, réfringent; très abondantes près de l'arête, (40-)45-55(-60) x (6-)7-8(-9) µm, à paroi remarquablement épaissie (lamprocystides), parfois à paroi plus mince et alors plus petites, mais plus larges (35-45 x 9-13 µm), à contenu granulé-réfringent, concentré au sommet. **Revêtement piléique** formé d'hyphes entremêlées, peu gélifiées, droites ou sinueuses, 2-5 µm de large, obtuses, optiquement vides, surmontées d'un trichoderm discontinu, à poils de 3 à 6 articles globuleux-ellipsoïdes, 10-20(-30) µm de diam., contenant quelques granules réfringents; l'article apical le plus souvent obtus, lagéniforme ou longuement appendiculé. Pileocystides abondantes; les unes naissant entre les poils, (17-)20-35 x (5-)6-8(-9) µm, clavées, parfois même pédicellées, subfusiformes, obtuses ou mucronées, parfois à paroi un peu épaissie, à contenu pailleté-réfringent ou localement granuleux; les autres naissant dans le subpellis et alors beaucoup plus grandes, 33-70(-125) x 6-8 µm, subcylindracées à clavulées. Hyphes oléifères peu rares. **Revêtement du stipe** composé d'hyphes grêles, 2-4 µm de diam., peu gélifiées et densément entremêlées, émettant, en haut du stipe, un suprapellis discontinu, le plus souvent composé de poils réunis en touffes; vers la base du stipe à revêtement continu, très dense; les poils formés d'articles de 6-13 µm de large; le terminal assez versiforme, le plus souvent ampulacé, lagéniforme ou lancéolé, obtus ou mucroné au sommet. Vers la base du stipe tous les articles - mais surtout le terminal - sont moins volumineux que dans le haut et plus souvent subulés ou effilés en bec grêle au sommet. Caulocystides abondantes en haut du stipe, de dimensions très variables, (14-)25-50(-75) x 6-8(-13) µm, devenant très abondantes vers la base du stipe, (25-)30-40(-45) x 6-8 µm, cylindracées, clavées à fusiformes, parfois un peu rétrécies vers le sommet, à contenu pailleté-réfringent; cystides du subpellis un peu plus longues, mais moins frappantes que dans le chapeau.

Bolivia : Beni, Vaca diez, Guayaramerin, mars 1956, Singer B1761 (F holotypus).

RUSSULA LAMPROCYSTIDIATA sp. nov.

Pileus fragilissimus, 30-40 mm diam., planus, sed leviter depressus in centro; margo regularis, paulum in-

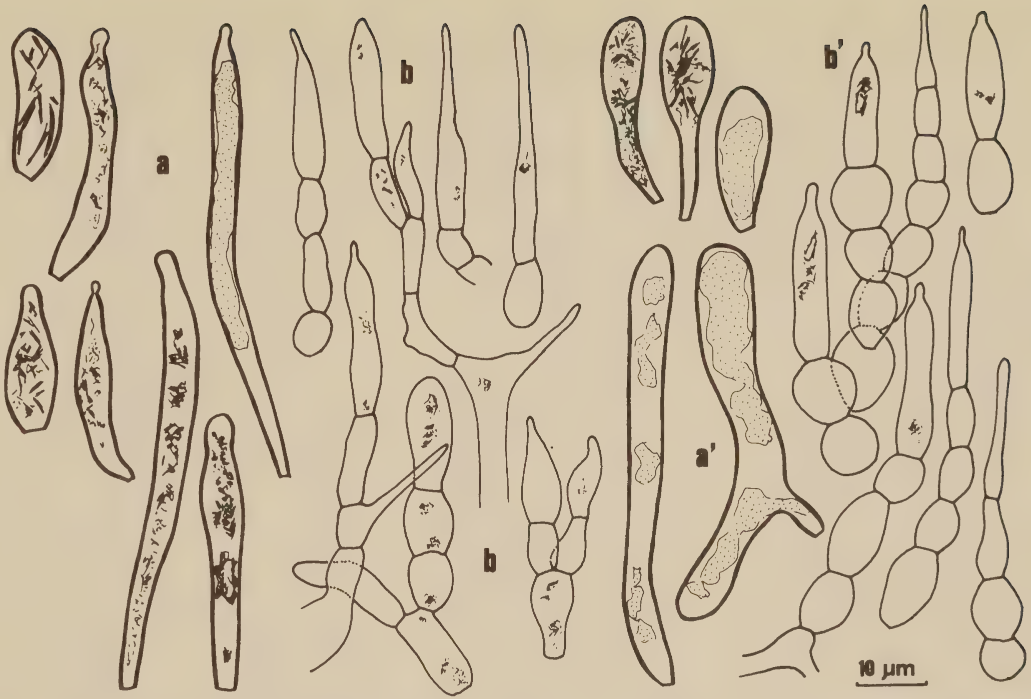

Fig. 1 : *R. guayarensis*, éléments du revêtement piléique. a-a' : dermatocystides montrant la paroi légèrement épaissie et le contenu granuleux-pailleté, au centre (a') et vers la marge (a) du chapeau; b-b' : poils contenant souvent une granulation d'origine probablement pigmentaire, au centre (b') et vers la marge (b) du chapeau.

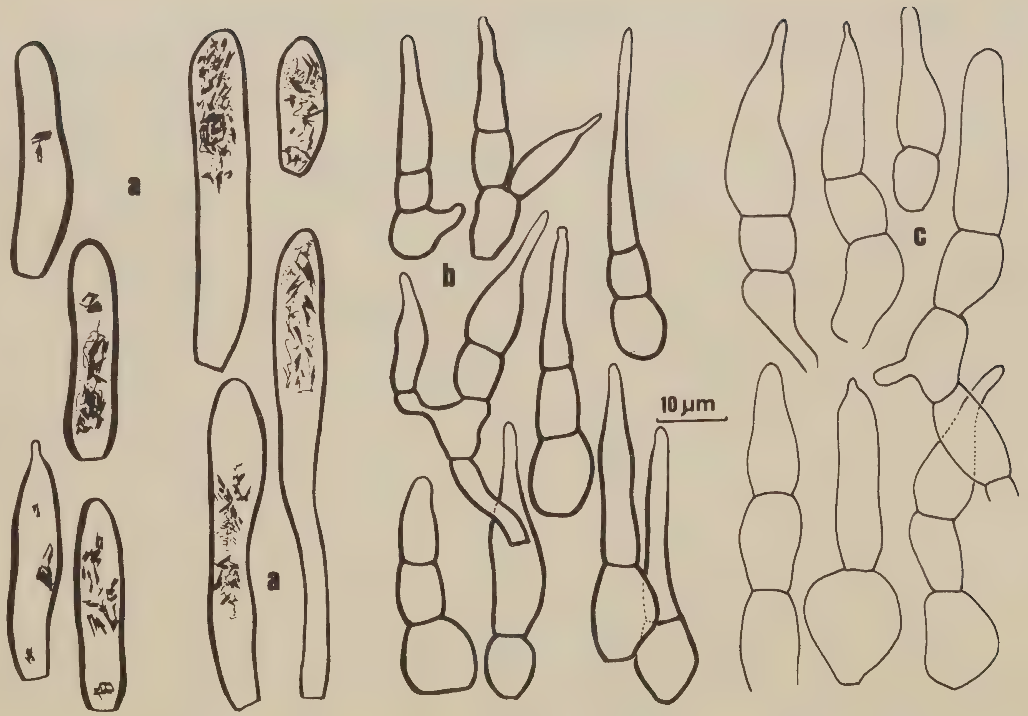

Fig. 2 : *R. guayarensis*, éléments du revêtement du stipe. a : caulocystides; b-c : poils du revêtement à paroi légèrement épaissie, près de la base (b) et au sommet (c) du stipe.

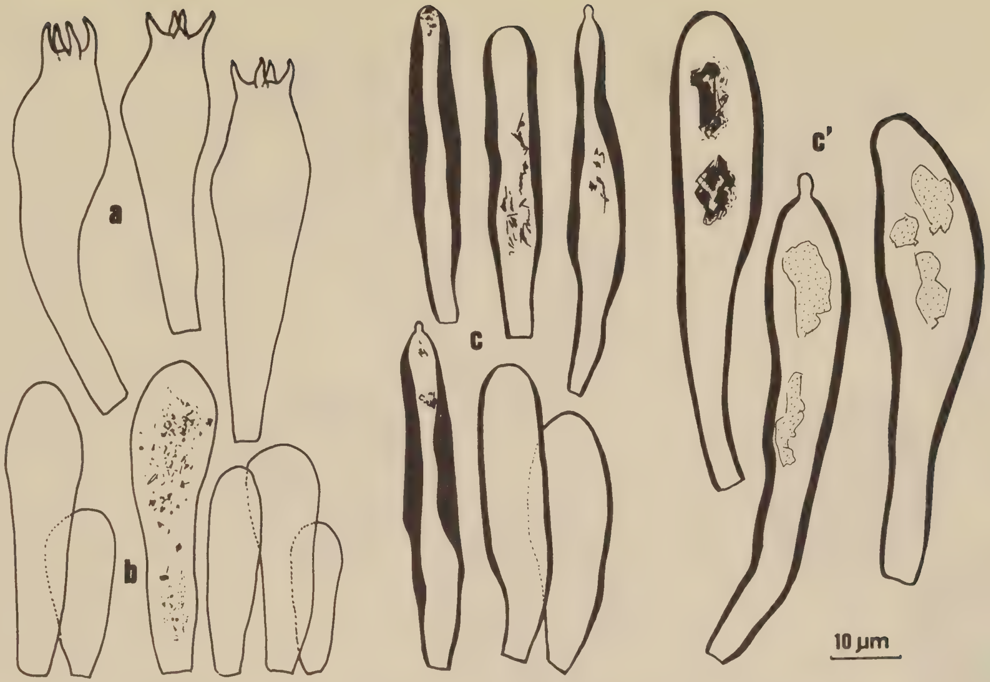

Fig. 3 : *R. guayarensis*, a : basides; b : basidioles, avec indication du contenu parfois granuleux dans une entr'elles; c-c' : cystides montrant la paroi parfois très fortement épaissie près de l'arête (c) et sur la faces (c') des lamelles; remarquez le contenu granuleux, peu abondant.

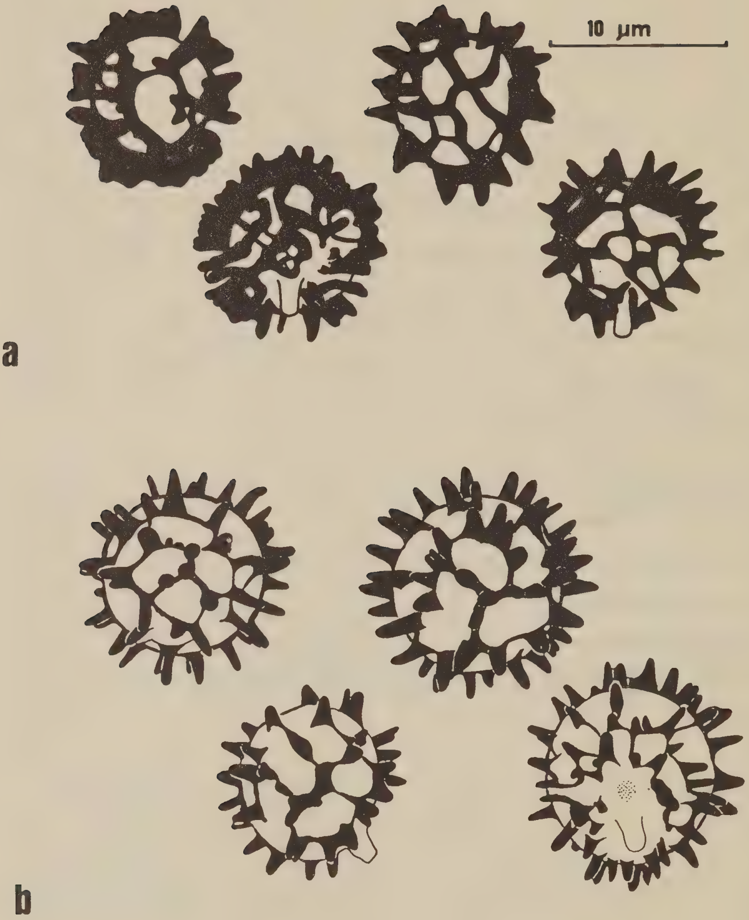

Fig. 4 : Ornementation sporale, observée dans le réactif de Melzer; a : *R. guayarensis*, b : *R. lamprocystidiata*.

curvatus, subtiliter striatus; pileipellis secernens, marginem versus in areolis magnis crassis mollibus saturate griseis plus minusve concentrice modo dispositis rumpens; pileipellis inter areolis pallidior, griseobrunnea, saturate brunnea in centro. **Stipes** longus, gracilis, 70-80 x 6-8 mm, cylindricus, glabrus, sordide albidus, leviter flavescens. **Lamellae** adnatae, breviter subdecurrentes, 3-4 mm latae, angustae, confertae (11/cm); acies concolor, integra. **Caro** spongiosa, alba, grisescens per actione vermorum, inodora, mitis. **Sporae** in cumulo colore ignoto, probaliter pallidae.

Sporae subglobosae, 10,39 ±1,32 x 9,76 ±1,19 µm (Q = 1,06), spinis longis, usque ad 2,5 µm altis, dense reticulatis per trabeculis subtilibus, hic illic catenulatis; macula suprahilaris inamyloidea. **Basidia** (35-)40-47 x 13-18 µm, subclavata, tetraspora, intus contentu granulosa repleta; sterigmata 4-6 x 2-3 µm. **Cystidia** sparsa in lateribus, 60-90 x (7-)13-18 µm, voluminosa, subfusiformia, obtusa vel mucronata, tenuitunicata; in acie numerosa, 40-53(-65) x 7-13(-20) µm, fusiformia, lageniformia, torulosa, plerumque indistincte capitata, pariete irregulariter sed plerumque fortiter incrassata azureo cresylico haud metachromatica praedita, hic illic autem tenuitunicata. **Pileipellis** ex hyphis gracilibus gelatinosis, 2-4 µm diam. efformata; pili suprapellis cellulis 30-70 x 6-15 µm, lageniformibus sinuosis obclavatis ampullaceis, ex cellula globosa basale haerentibus compositi. Pileocystidia modice numerosa, 35-55 x 5-8 µm, lageniformia, subulata vel subfusiformia, obtusa, intus contentu granulosa refringente repleta, pariete tenuiter incrassata praedita.

Zaïre : Forestier central : Binga, épars sur le sol de la forêt sèche, févr. 1933, Goossens-Fontana 966 (BR holotypus).

OBSERVATIONS

(1) : La description macroscopique de *R. lamprocystidiata* est basée sur les notes et l'aquarelle de Mme Goossens-Fontana. L'espèce sera illustrée en détail dans une révision des Russules tropicales africaines, à paraître bientôt dans la "Flore Illustrée des champignons d'Afrique centrale" du Jardin botanique national de Belgique.

(2) : *R. lamprocystidiata* ressemble *R. guayarensis* tout d'abord par la possession d'abondantes lamprocystides sur l'arête des lamelles (unique jusqu'alors dans le genre !), mais aussi par la couleur du chapeau et du stipe : toutes deux ont le stipe légèrement jaunissant et possèdent un chapeau grisâtre à centre brunâtre, dont le revêtement est couvert d'un voile sous forme de flocons petits, fugaces et marginaux dans *R. guayarensis* et sous forme

d'écailles molles et épaisses radiant du centre dans *R. lamprocystidiata*. Chez cette dernière, comme dans *R. guayarensis*, il n'y a pas de tissus ou de cellules métachromatiques au bleu de crésyl.

Les deux espèces se distinguent entr'elles surtout par la structure diffèrente des poils des revêtements et par l'ornementation sporale. A présent, il me semble préférable de réunir les deux espèces dans les *Guayarenses* par la présence d'innombrables lamprocystides sur l'arête des lames et par la présence d'un velum sur le chapeau.

(3) : Les deux Russula sont caractérisées en outre par l'absence de toute réaction métachromatique au bleu de crésyl. Ceci les distancie des *Metachromaticae* Singer, qui possèdent également des lamprocystides, mais la paroi de celles-ci rougit énergiquement dans le bleu de crésyl et n'atteint pas l'épaisseur relative des cystides marginales des *Guayarenses*. Dans les *Metachromaticae* les cystides marginales n'occupent pas l'arête entière et les lamprocystides s'observent également, ou surtout, sur les faces des lames.

(4) : Dans une contribution aux *Russulaceae* de la Nouvelle-Zélande, McNabb (1973) a décrit 32 *Russula* dont quelques-unes possèdent également des cystides à paroi épaissie, atteignant environ 2 à 3 µm et même 6 µm d'épaisseur dans R. tawai McNabb.

D'après mes propres observations dans les *Russula* africaines, une épaisseur de 2 à 3 µm pour la paroi des cystides n'est pas rare du tout et même fréquente dans plusieurs sous-sections tropicales (obs. pers.).

Seule *R. tawai* possède donc des cystides ou l'épaisseur relative des parois égale celle des cystides marginales des *Guayarenses*. McNabb (1973 : 708) situe *R. tawai* dans les *Amoeninae* Singer mais les caractères microscopiques contredisent cette parenté. Je n'ai pas encore étudié personnellement le type de *R. tawai* car, vu le caractère particulier de la flore Nouvelle-Zélandaise, l'examen des espèces décrites par McNabb n'est vraiment utile que lors qu'on puisse étudier la totalité de ces espèces. McNabb avait apparamment quelques problèmes de situer ses espèces nouvelles dans la classification du genre, connaissant probablement trop peu les espèces de l'Europe et de l'Amérique.

Néanmoins, l'examen du type de *R. echinospora* Heim non Singer de la Nouvelle-Calédonie nous permet de situer *R. tawai*. Ces deux Russules sont certainement très proches et peut-être même identiques (dans les deux cas R. tawai McNabb reste un nom légitime car Singer (1939 : 270) avait publié déjà le nom '*echinospora*' dans un nom alternatif mais légitime parce qu'avant 1953). Heim (1967 : 7) décrit la paroi des cystides hyméniales de *R. echinospora* comme "égale et peu épaissie", bien qu'elle soit tout à fait comparable et parfois aussi fortement épaissie que la paroi des cystides de *R. tawai*. L'ensemble des caractères,

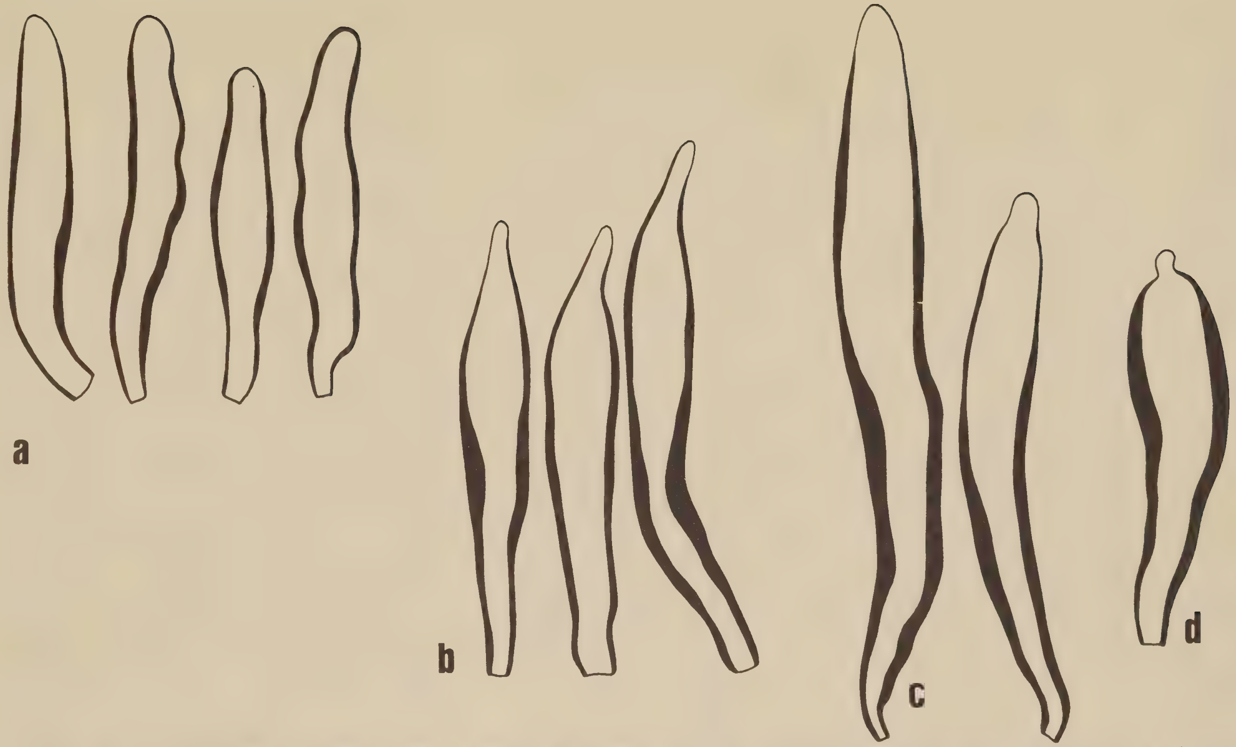

Fig. 5 : Cystides hyméniales à paroi épaisse. a : *R. metachromatica* ssp. *notoleuca* Singer, b : *R. echinospora* Heim, c : *R. binganensis* Beeli, d : *R. luteopulverulenta* Beeli.

macroscopiques et microscopiques, excluent toute parenté avec les *Guayarenses* mais sont plutôt en faveur d'une position près des *Fistulosinae* Heim ex Singer dans une sous-section nouvelle.

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Etudes microscopiques de Russules tropicales : Mimeticinae subsectio nov.

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Résumé : La sous-section *Mimeticinae*, subsect. nov. est décrite. Quatre espèces lui sont attribuées : *Russula mimetica* Heim, *R. obtusopunctata* (Singer) Buyck nom. nov. pour *R. heterochroa* Singer, *R. leguminosarum* Singer et *R. atrovinosa* Buyck sp. nov.

Summary : the subsection *Mimeticinae* subsect. nov. is described. Four species are assigned to it : *Russula mimetica* Heim, *R. leguminosarum* Singer, *R. obtusopunctata* (Singer) Buyck nom. nov. for *R. heterochroa* Singer and *R. atrovinosa* Buyck sp. nov.

INTRODUCTION

Lors de notre étude des spécimens - types des *Russulaceae* décrites par Singer de l'Amérique du Sud, nous nous sommes aperçus de quelques similitudes inattendues avec plusieurs groupes d'espèces de la flore africaine, particulièrement riche en *Russulaceae*. En étudiant les spécimens - types des *Pluviales* Singer (BUYCK 1989) nous avons été frappés par les ressemblances entre *R. leguminosarum* Singer et *R. mimetica* Heim. Nous pouvons affirmer à présent qu'il s'agit d'un nouvel ensemble d'espèces, pour lequel nous proposons le nom *Mimeticinae* subsectio nov. et auquel nous rattachons également *R. heterochroa* Singer (non Kühner 1975), ainsi que *R. atrovinosa* Buyck sp. nov. du Zaïre, dont la diagnose latine est fournie ci-dessous.

DESCRIPTION DES ESPECES

R. mimetica Heim et *R. atrovinosa* Buyck sp. nov. seront décrites et illustrées en détail dans notre révision de *Russula* en Afrique centrale, qui paraîtra prochainement dans la Flore Illustrée des Champignons d'Afrique Centrale, publiée par le Jardin botanique national de Belgique. Pour une étude détaillée des caractères microscopiques de *R. leguminosarum*, nous renvoyons le lecteur à notre étude des *Pluviales* Singer (BUYCK, l.c.). Nous nous contenterons ici d'une description des caractères microscopiques du type de *R. heterochroa* Singer.

L'exsiccatum a été traité par une solution aqueuse (ca. 20%) de KOH pour faciliter la dissociation et le regonflement des tissus, dont l'étude s'est effectuée à partir de préparations semi-permanentes dans le Congo ammoniacal additionné de 10% de glycérine. Les dimensions sporales, basées sur vingt spores, donnent la longueur et la largeur moyennes, accompagnées de leur écart type (standard deviation); suit encore, entre parenthèses, le rapport moyen de la longueur sur la largeur.

R. obtusopunctata (Singer) Buyck nom. nov.
R. heterochroa Singer Beih. Nov. Hedw. 77 : 273 (1983) non Kühner Bull. Soc. mycol. France 91 : 389 (1975).

Spores brièvement ellipsoïdes à subglobuleuses, 6,82 ± 1,12 x 6,06 ± 1,11 µm (Q = 1,13), assez densément ornées d'éléments obtus, isolés, forts, courtement cylindracés à plus ou moins coniques, atteignant env. 1 µm de haut, parfois légèrement convexes ou hémisphériques, nettement amyloïdes; plage non à très légèrement amyloïde, verruculeuse. **Basides** généralement 35-42 x 8-10(-12) µm, piriformes à clavulées, contenant des globules réfringentes et probablement lipidiques de taille variable; stérigmates 4-6 x 1-2 µm; basidioles clavées. **Cystides** assez nombreuses mais peu apparentes, effleurantes, naissant assez profondément dans le subhyménium, 45-50 x 7-9 µm, cylindracées à subfusiformes, obtuses à largement capitées par un rétrécissement subapical, à paroi très mince et fragile; contenu abondant, granuleux-réfringent. **Poils cystidiformes** non différenciés. **Revêtement piléique** composé d'hyphes emmêlées, écartées par gélification, généralement 2-3(-4) µm de diam., parfois très légèrement métachromatique au bleu de crésyl; hyphes oléifères dispersées, rares; suprapellis discontinu, formé de poils le plus souvent groupés en touffes, ramifiés, naissant généralement par plusieurs d'une même cellule basale, composés de 2-4 articles courts, globuleux, doliformes à ellipsoïdes ou brièvement cylindracés, à paroi mince mais nettement métachromatiques au bleu de crésyl; le terminal toujours plus long, atteignant parfois 30 µm, s'atténuant graduellement vers le sommet, celui-ci obtus ou subapicalement rétréci en large capitule. Pileocystides abondantes, 15-30 x 3-5 µm, constituant l'article terminal des poils et ressemblant aux articles terminaux ordinaires par la forme lancéolée, lagéniforme, conique ou subfusiforme ainsi que par la paroi métachromatique, parfois minusculement capitées, rarement arrondies au sommet; contenu granuleux-réfringent. **Revêtement du stipe** plus mince, moins gélifié, à éléments plus grêles, mais tout à fait ressemblant à ceux du chapeau.

Brésil : Amazonas, Estrada Manaus-Caracarai, Rus 125, mai 1978; Singer B11012 (INPA holotypus).

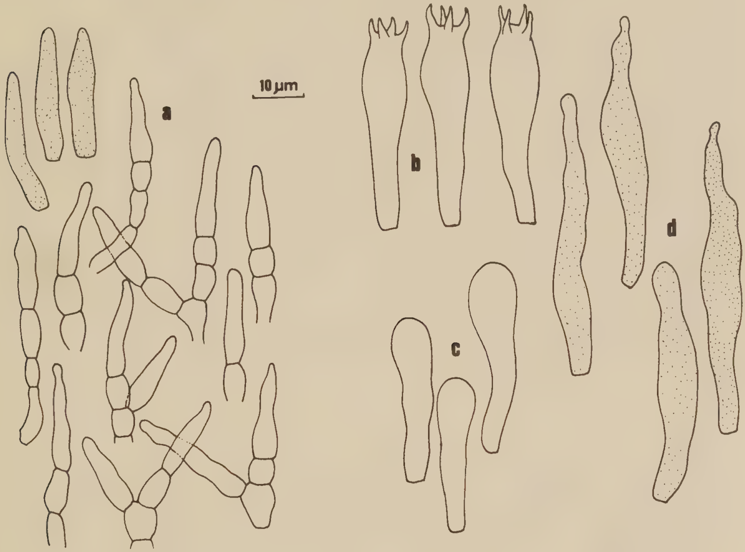

Fig. 1 : *R. obtusopunctata* (holotypus) : a : dermatocystides (à contenu schématisé) et poils du revêtement, b: basides, c : basidioles, d : cystides (à contenu schématisé).

Fig. 2 (au verso) : *R. radicans* (Gilles 71 holotypus, P) : a : extrémités de dermatocystides, remarquez le contenu pailleté; b : poils optiquement vides du revêtement piléique; c : basidioles - je n'ai pas réussi à trouver des basides bien regonflées; d : cystides à contenu partiellement schématisé; remarquez le sommet toujours obtus-arrondie et la taille parfois énorme, nettement supérieure aux dimensions fournies dans la description originale.

Fig. 3 (au verso) : *R. nanella* (Singer B 10923 holotypus, INPA) : a-c : revêtement piléique, poils aciculaires (a), articles terminaux ordinaires des poils (b) et détail d'une coupe tangentielle (c).

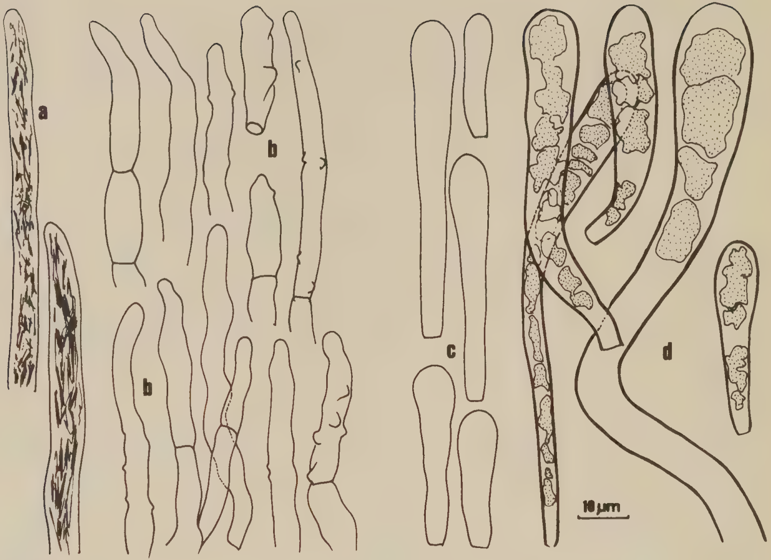

Figure 2

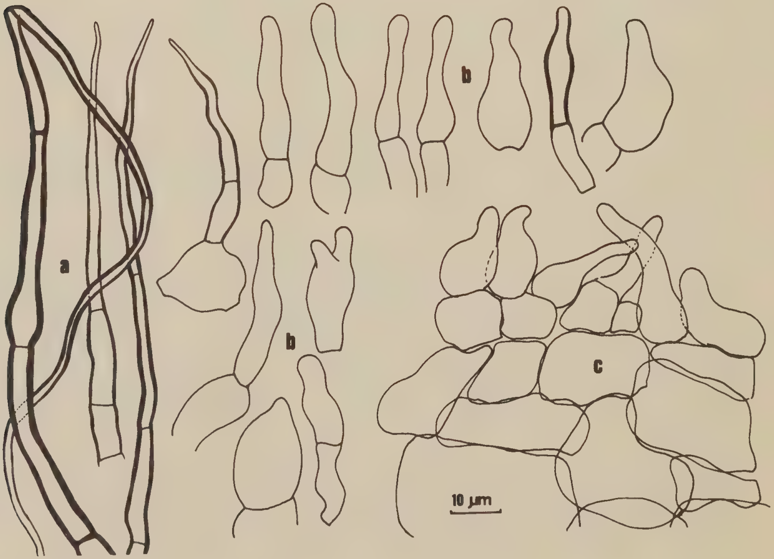

Figure 3

R. atrovinosa Buyck spec. nov. a *R. mimetica* Heim praesertim differt colore pilei stipitisque atrovinosa, sporis sublaevibus, elementis paululum convexis sejunctis generaliter dilute amyloideis ornatis.

Zaïre : Haut-Katanga, Lubumbashi, en forêt claire, mars 1986, Schreurs 1500 (BR holotypus).

DISCUSSION

R. mimetica a été décrite du Gabon par Heim (1969 : 347) et il la situa (1970 : 67) au sein des *Pelliculariae* Heim *nom. nud.* près de *R. radicans* Heim dans les *Radicantes* Heim *nom. nud.* à cause de la présence d'un anneau, le stipe radicant et les spores ovoïdes non réticulées. Dans sa description de *R. mimetica*, Heim ne dit rien sur la composition des revêtements, bien que ce soit justement ce caractère qui contredit une parenté étroite entre les deux espèces : *R. radicans* possède un chevelu de poils assez larges, généralement 4-7 µm de diam., cylindracés, rarement avec quelques articles basaux plus ou moins renflés-ampullacés, montrant fréquemment de courts diverticules latéraux et aigus; l'article terminal obtus, parfois légèrement rétréci. Les dermatocystides cylindracées, très longues, excédant parfois un peu le diamètre des poils, naissent très profondément dans le subpellis. (cf. notre Fig. 2 ou Heim 1937, fig. 46).

En ce qui concerne les caractères des éléments hyméniaux de *R. mimetica*, Heim ne se révèle pas très précis non plus : les basides sont nettement moins grandes que Heim le ferait supposer et les stérigmates "énormes" sont beaucoup plus petits que, par ex., ceux des *Nigricantinae* ou *Fistulosinae* Heim. Enfin, je ne comprend pas très bien ce que Heim veut dire par 'poils cystidiformes", car les cystides de *R. mimetica* dépassent largement les dimensions données tandis que les vrais poils cystidiformes de l'arête correspondent bien aux dimensions citées mais possèdent une structure tout à fait différente.

On pourrait difficilement envisager une insertion parmi les *Pluviales* Singer où Singer situe *R. leguminosarum*, puisque nous avons démontré (BUYCK 1988) que cette dernière diffère considérablement de *R. pluvialis* Singer par la nature très différente des cystides et dermatocystides, lesquelles, dans *R. pluvialis*, sont très apparentes, très nombreuses, à contenu nettement plus abondant et à paroi plus épaisse.

Singer (Singer et al., 1983 : 274) avait interprêté sa *R. heterochroa* au début comme une simple variété de *R. nanella* Singer, mais l'en séparait à cause de la coloration différente du chapeau et la microscopie : "although similar, not quite identical". Ayant étudié le type de *R.*

nanella j'ai trouvé les caractères microscopiques des deux espèces tellement différentes qu'on pourrait se demander si Singer ne parle pas d'un autre spécimen ! Surtout la structure du pileipellis est totalement différente (les traits schématisés de Singer illustrant les deux espèces sont d'ailleur fortement trompeurs !) : dans les *Mimeticinae,* sa structure est surtout filamenteuse avec un suprapellis nettement discontinu, formé de poils groupés en touffes, unis par leur article terminal; le suprapellis de *R. nanella* (Fig. 3), au contraire, est continu, entièrement orthochromatique au bleu de crésyl et de structure pseudoparenchymateuse (s'approchant du type 'virescens') formé d'articles renflés se poursuivant jusqu'à l'hyménium ! On n'aperçoit aucune hyphe grêle dans tout le pileipellis. A la surface du chapeau les cellules sont ampullacées, subulées ou ellipsoïdes-globuleuses avec en outre des poils très longs, dispersés, subulés, à paroi fortement épaissie (ces structures caractérisent également un groupe de Russules africaines, obs. pers.).

R. nanella et *R. heterochroa* Singer non Kühner sont classées par Singer parmi les *Cyanoxanthinae*. Bien que, à part quelques réserves pour *R. amnicola* Singer dont je n'ai reçu que deux primordia, aucun des cinq représentants sud-américaines énumérés pour cette sous-section ne soit apparenté à *R. cyanoxantha* !

Nous croyons donc justifié de décrire, pour nos quatre espèces, une nouvelle sous-section dont les caractères essentiels se résument comme suit :

Mimeticinae subsectio nov. : species versicolores, minutae (diametro pilei inferiore 40 mm), pelliculares; stipes albus vel pileo concolor; caro insipida, fere inodora; pileipellis ex pilis caespitosis dermatocystidiisque pariete dilute azureo cresylico metachromatica instructis composita; sporae breviter ellipsoideae, elementis sejunctis ornatae, macula suprahilare inamyloidea vel leviter amyloidea instructa, in cumulo probabiliter albae (certe valde pallidae).

Espèces versicolores, très petites (diam. du chapeau ne dépassant pas 40 mm), pelliculaires; stipe blanc ou concolore au chapeau; chair douce, à peu près inodore; revêtement piléique composé de poils et de dermatocystides légèrement métachromatiques au bleu de crésyl; spores brièvement ellipsoïdes, ornées d'éléments isolés, à plage non ou très légèrement amyloïde; sporée probablement blanche (en tout cas très pâle). Espèce-type : *R. mimetica* Heim.

Clé des espèces

Remarque : la clé devra être utilisée avec prudence, toutes les espèces n'étant connues que par leur type !

Spores sublisses, à ornementation ne dépassant pas 0,5 µm de haut; chapeau rouge vineux foncé; stipe concolore, sans anneau (Zaïre).- Fig. 4a, 5a
R. atrovinosa Buyck

Spores ornées d'éléments atteignant généralement 1-1,5 µm de haut.

Espèce annelée à chapeau rose foncé et stipe plus ou moins concolore. (Gabon).- Fig. 4d
R. mimetica Heim

Espèce dépourvue d'anneau.

Chapeau brun ocracé subtilement mélangé de vert; stipe blanc à concolore; spores grossièrement ornées d'éléments forts et obtus. (Brésil).- Fig. 4b, 5b
R. obtusopunctata (Singer) Buyck

Chapeau lila violacé à violacé sale mélangé de vert; stipe blanc pur; spores ornées d'éléments grêles et assez aigus. (Brésil).- Fig. 4c, 5c
R. leguminosarum Singer

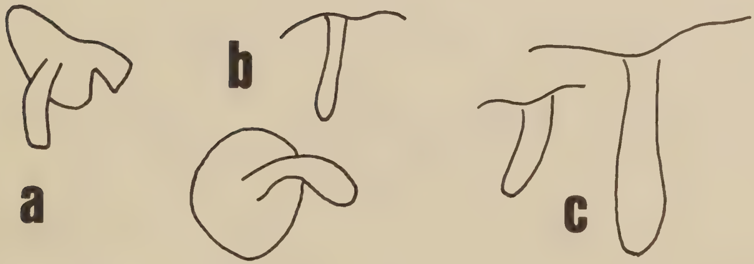

Fig. 5. Traits schématisés de l'habitus (d'après les publications originales pour b & c). a : *R. atrovinosa*, b : *R. obtusopunctata*, c : *R. leguminosarum*; toutes grandeur naturelle.

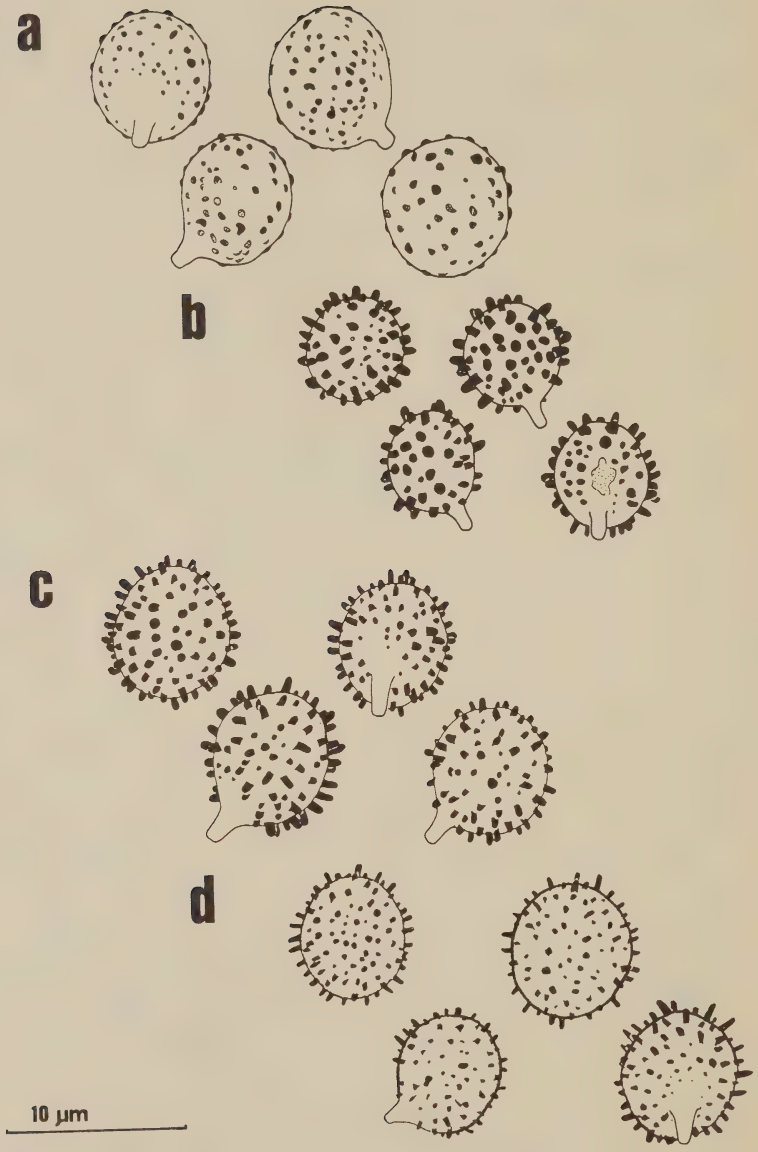

Fig. 4. Ornementation sporale. a : *R. atrovinosa*, b : *R. obtusopunctata*, c : *R. leguminosarum*, d : *R. mimetica*.

REMERCIEMENTS

Je tiens à remercier les directeurs des herbiers du Jardin botanique national de Belgique (BR), du Muséum National d'Histoire Naturelle, France (P.) et de l'Instituto Nacional de Pesiusas de Amazônia, Brésil (INPA) pour le prêt du matériel, ainsi que le Prof. Dr. P. Van der Veken et le Prof. Dr. P. Heinemann pour une lecture critique du manuscrit.

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MYCOTAXON

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CHEILYMENIA MEGASPORA COMB. NOV. A NEW COMBINATION IN THE GENUS CHEILYMENIA (DISCOMYCETES, PEZIZALES, PYRONEMATACEAE)

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ABSTRACT: A new combination, *Cheilymenia megaspora* (Gamundí) comb. nov. is proposed on the basis of the author's examination of the type material. The examination of the type of *Cheilymenia coprinaria* var. *megaspora* Gamundí (1972) revealed an outstanding cyanophilic perisporial ascospore ornamentation, well observable under light microscope and proved by SEM photomicrographs. The type of *Peziza coprinaria* Cooke (=*Cheilymenia coprinaria* (Cooke) Boud.), differs by much smaller ascospores with a smooth perisporium. The very long furcated apothecial rooting hairs well differentiate *Ch. megaspora* also from *Cheilymenia raripila* (Phill.) Dennis and other species with similar ascospore ornamentation.

Line drawings and SEM photomicrographs of ascospores of *Ch. megaspora* accompany the paper and complete the detailed description and illustration previously given by Gamundí (1972).

Gamundí (1972) described a new variety of *Cheilymenia coprinaria* (Cooke)Boud. var. *megaspora* Gamundí. She examined seven collections from Tierra del Fuego, Argentina, coming from cow-dung and horse excrements. The detailed description and line drawings of all features in this variety show several essential features, which differentiate, in my opinion, this taxon from *Cheilymenia coprinaria* (Cooke) Boud. (= *Cheilymenia fimicola* (De Not.)Dennis according to Dennis (1978)) not only at the infraspecific level. The examination of the type material has confirmed this opinion. The type specimen from the herbarium of M.C.Cooke, now deposited in Kew Herbarium (K) and labelled "*Peziza* (*Sarcoscypha*) *hyppocopra* Cooke"(an herbarium name) and designated " the type of *Cheilymenia coprinaria* (Cooke)Boud.: Rannoch, Scotland,(no date), on horse dung" (studied and designated as holotype by Denison (1964)), contains apothecia in a rather bad condition but with fully mature copious ascospores. The ascospores measure 15-16.5(-18) x 7.5-9.7(-10.5) µm, are hyaline without oil guttules, with a pale yellow refractive colour at their maturity seen when stained with CB; the perisporium is loosen, gentle, smooth, with only occasional secondary fine patches or stained places caused by the wrinkling as stained with CB. The rooting apothecial yellow-brownish hairs are up to 730 µm long and 45 µm diam., with walls up to 4.5 µm thick, base only shortly rooting. These features well agree with the description and illustration in Cooke (1876). For the detailed description see also Denison (1964).

It may be noted that although Dennis (1978) transferred Arhenia fimicola De Notaris to Cheilymenia as Cheilymenia fimicola (De Not.) Dennis, the ascospore size given by him is larger (up to 23 x 13 µm) and this taxon may represent a different species. However, the type of A. fimicola have not been yet examined by me.

The examination of the type of Ch. coprinaria var. megaspora, deposited in LPS herbarium (N° 33424), revealed that this Gamundí's variety differs not merely in its ascospore size, but also in several other important features. The ascospores are without guttules and with a conspicuous yellow refractive colour (the latter feature seen when stained with CB) and measure (22.5-) 25-29.5(-31.2) x 12-13.5(-15) µm and this size itself is significantly distinct from that in ascospores of Cheilymenia coprinaria. However, the most important feature, which differentiates sufficiently the two taxa, is the ornamentation of the perisporium of ascospores in var. megaspora (fig.1 and figs 3-5). This ornamentation is well seen when the sections are stained with Cotton blue in lactic acid (CB Geigy s.123), which stains promptly without heating the slides, and, when oil immersion objective is used. It should be noted that when the slides with stained sections are heated, the perisporium is easily deformed, loosened and separated from the ascospores, and they become smooth. This is probably the reason why Gamundí (1972,1975) stated the ascospores smooth. Similar situation is also in other species of Cheilymenia and Coprobia (J. Moravec 1984, 1987,1988).

The ornamentation is strongly cyanophilic and consists of very fine and low irregular amoeboid warts and crests, which are irregularly densely distributed and connected, occasionally forming an irregular and very incomplete reticulum. The warts are 0.1-0.6 µm diam. (elongated up to 1.2 µm long crests) and only 0.05-0.15 µm high, hardly seen on the outline of ascospores. These warts and crests represent an original ornamentation of the perisporium (a loose sheet) when the membrane is tense and not deformed by the action of lactic acid and is clearly seen on SEM photomicrographs taken from dried specimens (Figs 3-5).

The other important feature is the size and shape of asci. In var. megaspora, the asci are much larger, simply and shortly attenuated at their base. Moreover, the apothecia are smaller in var. megaspora and with apothecial rooting hairs longer (up to 1100 µm), usually with more copious septa and often containing one to three juvenile hairs, broadly rooting at their base (see line drawings in Gamundí(1972, 1975)).

For these reasons, especially the ascospore size and ornamentation, the new combination is proposed here:

Cheilymenia megaspora (Gamundí) comb. nov.

Basionym: Cheilymenia coprinaria (Cooke) Boud. var. megaspora Gamundí, Bol. Soc. Arg. Bot. 14 (3):170, 1972.

For the detailed description and illustration of other features, including the apothecial structure, see Gamundí (1972, 1975).

The species is well distinguished from all known species of the genus Cheilymenia Boud., and is known only from Argentina.

The ascospore ornamentation is similar to that in ascospores of Cheilymenia raripila (Phill.) Dennis. However, this species differs clearly by much smaller and simpler apothecia with short superficial apothecial hairs, and is not related to Ch. megaspora. Also other species are well distinguished.

For its long rooting apothecial hairs, Ch. megaspora may resemble a species of the genus Scutellinia (Cooke) Lamb. em. Le Gal. It should be noted that there seems to be a close relationship between the genera Cheilymenia and Scutellinia. As it has been already noted (J. Moravec 1984), there are several species in the genus Scutellinia (the members of the sections Minutae Svr. and Pseudocheilymeniae Svr.), which have ascospores with loosening perisporium, a feature, which was commonly overlooked in this genus. This also indigates the close relationship between the two genera. However, Ch. megaspora differs from these species of the genus Scutellinia by following features:
Its ascospores are without guttules, the mature ascospores possess the conspicuous yellow refractive colour when stained with CB, the perisporium is much feebler and easier separable, with much finer and lower ornamentation. Moreover, its habitat is entirely coprophilous.

I have examined the type of Cheilymenia rubra (Cooke ex Phill.) Boud., illustrated and described also in Cooke (1876) as Peziza (Sarcoscypha) rubra Cooke (K) and the neotype (LPS) of Cheilymenia humarioides (Rehm) Gamundí (1972). The both taxa differ from Ch. megaspora by the ascospore size, ornamentation, and by much shorter rooting apothecial hairs.

The detailed result of these examinations will be published later. It may be merely noted here that Ch. humarioides shows a certain similarity with Ch. rubra. The perisporial ascospore ornamentation in both taxa consists of rounded cyanophilic warts. However, these warts are much larger and very conspicuous (as seen also in SEM) in Ch. humarioides and the ascospore wall consists of three layers (as already stated by Gamundí (1972,1975)). In contrary, the ascospores of Ch. rubra have the perisporium with inconspicuous fine warts and the ascospore wall consists merely of two layers. Moreover, the apothecial hairs of Ch. rubra are much simpler at their base, and of a darker colour.
It should be noted that the collection from Greenland, determined by me previously (J. Moravec 1988) as Ch. humarioides, has almost all features virtually identical with these in the neotype of Ch. humarioides except the ascospore wall, which consists of two layers only, a feature, which deserves further study and evaluation.

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I thank Dr. Irma Gamundí de Amos (La Plata) and Dr. B.M. Spooner (Kew) for an arrangement of the loans of the type material. Mr. Jiří Lhotecký (Brno) has made the SEM photomicrographs of the ascospores, and, Dr. Zdeněk Pouzar (Prague) kindly read the manuscript.

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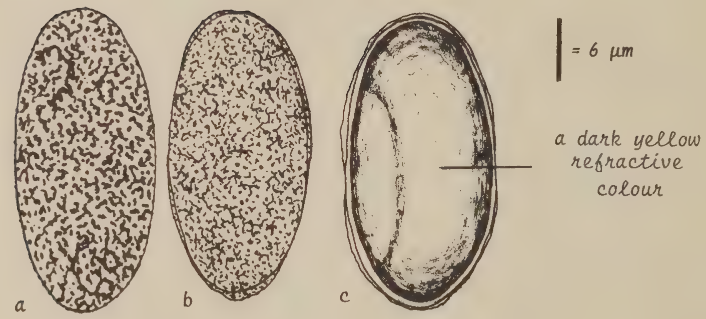


Fig. 1. Mature ascospores of Cheilymenia megaspora stained with cotton blue in lactic acid under oil immersion:
a, b. Ornamentation of the perisporium;
c. An optical section of an ascospore. (Holotype LPS 34424).

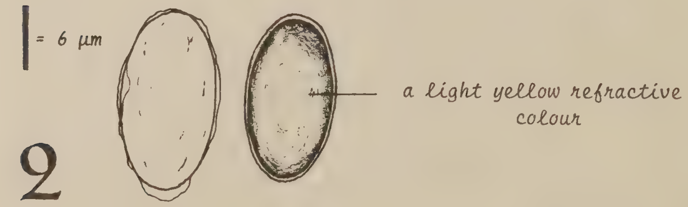
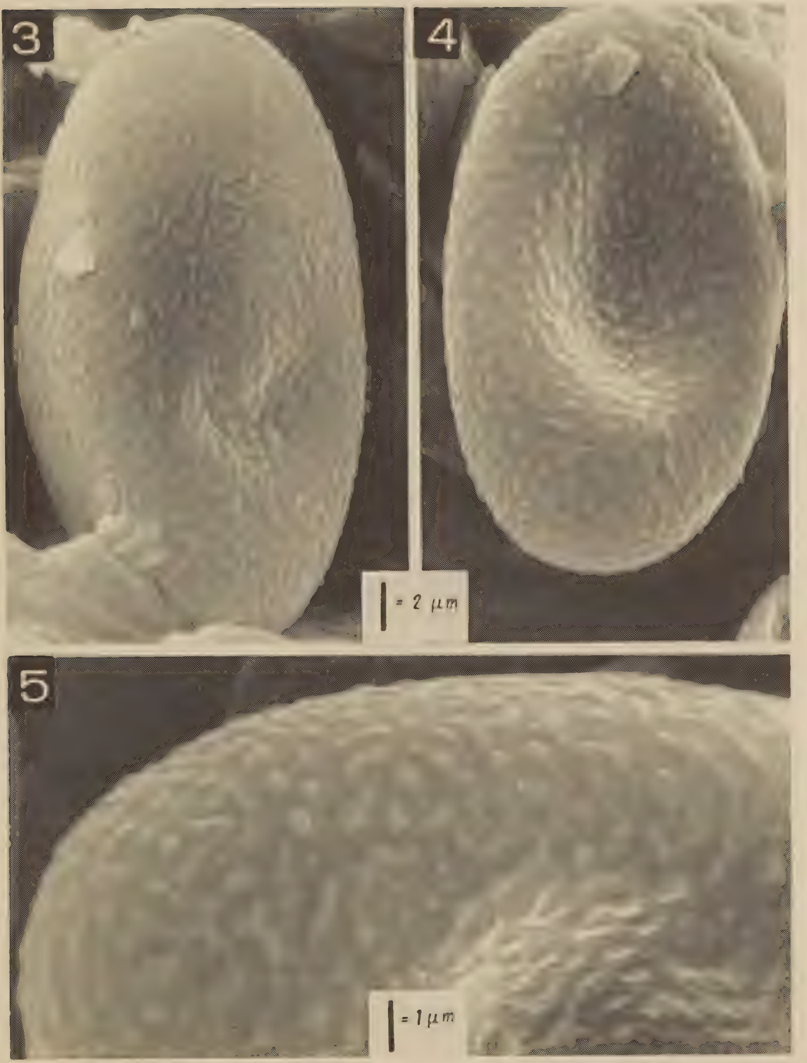


Fig. 2. Mature ascospores of Cheilymenia coprinaria stained with cotton blue in lactic acid under oil immersion: The type specimen (K).



Figs 3-5. SEM photomicrographs of ascospores of Cheilymenia megaspora. (Holotype LPS).

MYCOTAXON

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ON THE NEW GENUS JAPONOGASTER (LYCOPERDACEAE)

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A new fungus, described here as *Japonogaster oohashianus* gen. et sp. nov., was found on a dead trunk of *Fagus crenata* Blume at approximately 1000 m elevation in the forest at Kaifugôry, Tokushima Prefecture, by Takashi Oohashi. The holotype is preserved in the National Science Museum, Tokyo.

Japonogaster Y. Kobayasi, *gen. nov.*

Fructificatio epigaea stilpalis emortua, depresso-globosa, superficiale multi-foveolata. Epidermis crassa alba, in speciem unistrata. Gleba fulva multilocularis, hymeniis obsita. Basidia clavata, 2-sterigmata.

Japonogaster oohashianus Y. Kobayasi, *sp. nov.* (FIGS. 1, 2)

Fructificatio depresso-globosa, 2.5 cm in diam., 1.5 cm crassa, superne alba, multi-foveolata, alveoli cum corno polyhedrato, margine circulati praediti. Exoperidium alba, 1.5 mm crassa, e hyphis laxe tectis compositum, 1 mm crassum, pallide brunneolum, multi-foveolatum. Endoperidium 1.5 mm crassum, ochraceum, e hyphis densissime contextum. Capillitia crasseparietalia, pallide ochracea. Basidia clavata, 2-sterigmata, 19-20 x 3-4 µm. Basidiosporae globosae, 2.5-3.5 µm in diam., laevigate, hyalinae cum uniguttato. Holotypus in TNS conservatus: Epigaeous, growing on dead trunk of *Fagus crenata* Blume, in forest, about 1000 meters in altitude. Kaifugôri, Tokushima Pref. Collected by Takashi Oohashi, Jan. 2, 1981.

Fruitbody thick, discoid, 2.5 cm in diameter, 1.5 cm thick, surface white, turning pale ochraceous brown ["Pale Pinkish Buff" (Ridgway)] in the dried state. Epidermis 4 mm thick. Exoperidium white, 1.5 mm thick, composed of loosely woven hyphae, middle tissue pale brown, 1 mm thick, composed of hyphae, with many cavities, inner tissue yellowish, 1.5 mm thick, composed of densely woven hyphae. Many cavities produced on the surface of the fruitbody, containing one polyhedral cone margined with a circular elevation. Gleba ochraceous brown, composed of tramal hyphae, capillitia, basidia, and spores. Capillitium thick-walled, pale ochraceous. Basidia clavate, with two sterigmata, 19-20 x 3-4 µm. Basidiospores globose, 2.5-3.5 µm in diameter, smooth, hyaline, with one oil drop.

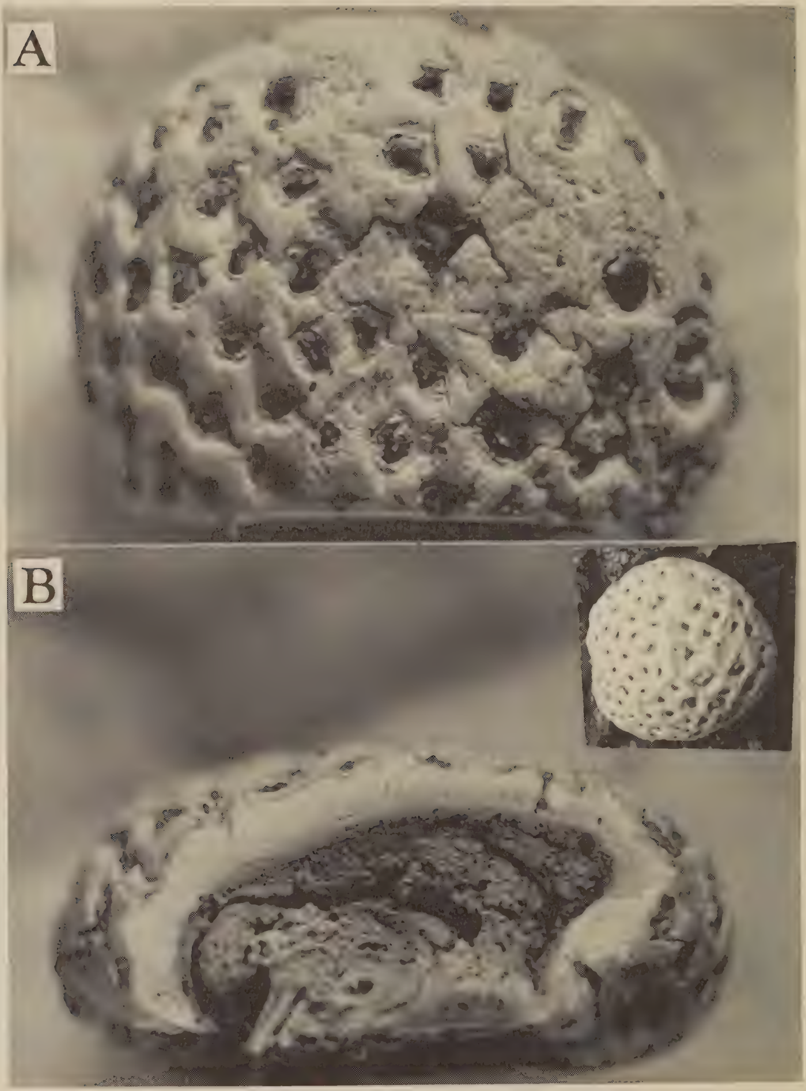

Fig. 1. A. Surface view of fruitbody. B. Section through fruitbody; insert: whole fruitbody.

This new genus recalls the genus *Calvatia* in shape, capillitium, and hyaline spores, differing, however, in the following characteristics:

Japonogaster	Peridium thick, composed of a single layer, not falling off at maturity.
Calvatia	Peridium thick, composed of two layers, falling off at maturity.

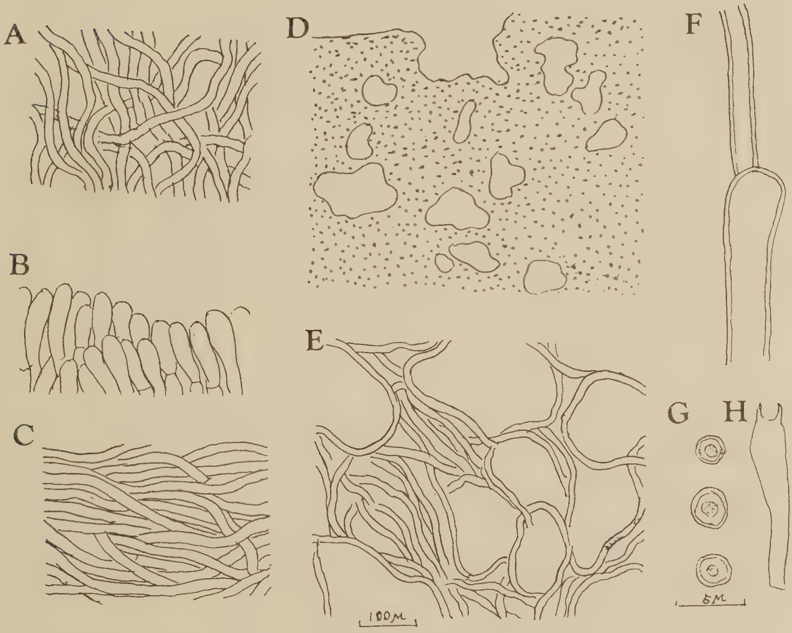

Fig. 2. A. Epidermis. B. Hymenial layer. C. Hyphae of inner tissue. D, E. Inner tissue. F. Capillitium. G. Basidiospores. H. Basidium.

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STUDIES IN THE GENUS XANTHOCONIUM (BOLETACEAE). III. CULTURAL STUDIES.

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ABSTRACT

Cultural studies of *Xanthoconium affine*, *X. affine* var. *maculosum*, *X. montanum*, and *X. montaltoensis* revealed distinct differences among them that have also supported the alpha taxonomic differences between them.

Key Words: Boletaceae, *Xanthoconium*, cultural studies.

Species of the Boletaceae are known mycobionts of ectomycorrhizae (Melin, 1922a, 1922b, 1923; Trappe, 1962; Singer, 1986; Palm and Stewart, 1984; Samson and Fortin, 1988). Pure culture isolation of the mycobionts of ectomycorrhizae has created a need for descriptions of cultures isolated from basidiomata (Zak, 1973; Palm and Stewart, 1984). Cultural studies of many boletes have been carried out by other workers (Pantidou, 1961, 1962, 1965; Pantidou and Groves, 1966; Pantidou and Watling, 1970, 1973; and Miller, Miller, and Palmer, 1983).

Wolfe (1987, 1988), Singer (1947, 1986), Snell and Dick (1970), and Smith and Thiers (1971) have summarized the suspected mycorrhizal associations of *Xanthoconium* Singer species. Ectomycorrhizal syntheses have not been conducted with *Xanthoconium* species and their suspected mycorrhizal symbionts. Additionally, descriptions of tissue cultures initiated from basidiomata of *Xanthoconium* species have not been forthcoming. Kneebone (1951), however, has germinated basidiospores of *X. affine* (Peck) Singer in vitro.

This present contribution presents the results of cultural studies of four *Xanthoconium* species.

MATERIALS AND METHODS

Pileus context tissue was aseptically removed from basidiomata of four *Xanthoconium* taxa and cultured on Hagem's agar modified by Modess (1941) that was supplemented with streptomycin sulfate and benomyl solutions (Watling, 1981). Thirty-day growth rate, morphological, and chemical spot test data were determined according to the methods of Pantidou (1961), Nobles (1965), and Miller, Miller, and Palmer (1983). Extracellular enzyme production was determined by growth on tannic acid agar (Davidson, Campbell, and Blaisdell, 1938) and chemical spot tests utilizing syringaldazine, L-tyrosine, phenol, gum guaiac, and guaiacol for the presence of laccase activity and tyrosinase activity (Marr, 1979). Hyphae were isolated from all culture zones, and the cell nuclei number (monokaryon or dikaryon) was determined by the Safranin O method (Bandoni, 1979). Color references (4A2) were determined by reference to Kornerup and Wanscher (1967) for names in quotation marks or subjectively.

Literature sources for the descriptions of the species are found in the species citations that follow, in Wolfe (1987, 1988), in Snell and Dick (1970), and in Smith and Thiers (1971).

RESULTS

Cultural characteristics of these *Xanthoconium* species were quite similar with some diagnostically significant exceptions. *Xanthoconium affine* (Peck) Singer was the only taxon to exhibit a positive guaiacol spot test. *Xanthoconium affine* and *X. montanum* Wolfe both exhibited a positive phenol test. Culture colors under ultraviolet (UV) light were diagnostically helpful. *Xanthoconium montanum* was the only taxon to exhibit the azonate culture mat.

Cultural Key to *Xanthoconium* Species

1. Mycelial mat zonate. 2
1. Mycelial mat not zonate. . . . .*X. montanum*
    2. Inner zone of mycelial mat cinnamon under UV light; vesicular hyphae absent. . .*X. affine* var. *maculosum*

ERRATA, VOLUME THIRTY-FIVE

Page 77 line 35 *for* 1.6.7.26.32.36.47.49.56 *read* 1.6.7.26.32.36.47.56

2. Inner zone of mycelial mat violet, purple, or ocher-green under UV light; vesicular hyphae present . .3
3. Guaiacol spot test positive (pink); inner zone of mycelial mat ocher-green under UV light . . . *X. affine*
3. Guaicol spot test negative; inner zone of mycelial mat dingy purple to violet . . . .*X. montaltoensis*

CULTURE DESCRIPTIONS

Xanthoconium affine (Peck) Singer. 1944. Mycologia 36: 362.
≡ *Boletus affinis* Peck. 1873. Annual Rep. New York State Mus. 25: 81.

FIGS. 1, 5

MACROSCOPIC CHARACTERISTICS: Mycelial mat 3.2-6 cm, surface white, reverse pale cream (4A2), pigment diffusion into agar absent, surface heterogeneous, aerial hyphae development moderate, zonate inner 1 cm, surface exudates none, yellow-green in outer zone and ocher-green in inner zone under UV light.

MAT MACROCHEMISTRY: $FeSO_4$ positive, pale yellow-green; NH_4OH and HCl negative.

MICROSCOPIC CHARACTERISTICS: Hyphae (2.6-)3(-6.4) µm diam., pale yellow in KOH, gold in Melzer's reagent, hyphal cytoplasm blue and walls hyaline in cotton blue, dikaryotic, outer zone hyphae mostly filamentous with little vesicular differentiation, inner zone hyphae differentiated with septate vesicular swellings (9.1-) 11.2(-14.3) µm diam., hyphal branching mostly subseptal, very rarely paarige; cytoplasm lipid positive, black in Sudan Black-B and red in Sudan IV, lipoidal bodies small to quite large, random, many localized in vesicular cells.

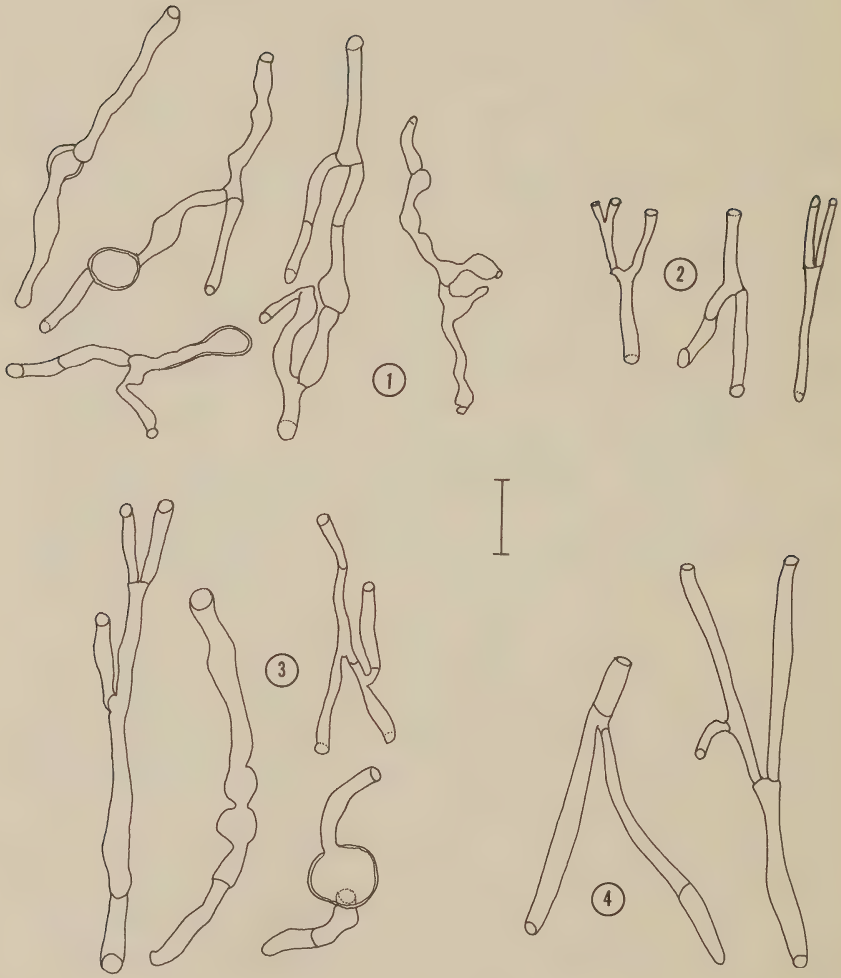
EXTRACELLULAR OXIDASE TESTS: gum guaiac, L-tyrosine, tannic acid agar, and syringaldazine negative; guaiacol positive, faint pink; phenol positive, vinaceous to rust-brown.

NOBLE'S KEY CODES: 1.6.7.26.32.36.47.49.56.

CULTURES EXAMINED: CBW-1671.

DISCUSSION. $FeSO_4$, guaiacol, and phenol mat spot tests were all positive as were the Sudan Black-B and Sudan IV microchemical tests. Of these, the phenol and guaiacol spot tests were unique and were of diagnostic value.

Xanthoconium affine var. *maculosum* (Peck) Singer. 1947. Amer. Midl. Naturalist 37: 89.
≡ *Boletus affinis* var. *maculosum* Peck. Annual Rep. New York State Mus. 32: 57.



Figs 1-4. Cultural hyphae of *Xanthoconium* species. Fig. 1. *X. affine*. Fig. 2. *X. affine* var. *maculosum*. Fig. 3. *X. montaltoensis*. Fig. 4. *X. montanum*. Standard line = 20 μm.

FIGS. 2, 6

MACROSCOPIC CHARACTERISTICS: Mycelial mat (2.8-)3 (-3.5) cm, surface white, reverse white to "yellowish white" to "pale yellow" (4A2,3), pigment diffusion into agar absent; surface zonate, inner zone with moderate aerial hyphae development, cottony, outer zone mostly submerged becoming progressively emergent toward the center; surface exudates absent; inner zone cinnamon colored, middle zone yellow-cinnamon colored, outermost zone pale yellow under UV light.

MAT MACROCHEMISTRY: $FeSO_4$, NH_4OH, and HCl negative.

MICROSCOPIC CHARACTERISTICS: Hyphae (1.5-)2.7(-4) µm diam., hyaline in KOH, hyaline to ocher yellow in Melzer's reagent, contents irregularly blue and walls hyaline in cotton blue, reagent positive contents scattered to gregarious in Melzer's reagent and cotton blue; dikaryotic; hyphal septation simple and distant; clamp connections absent; cytoplasm lipid positive, black in Sudan Black B and red in Sudan IV, lipoidal bodies randomly scattered and aggregated.

EXTRACELLULAR OXIDASE TESTS: guaiacol, gum guaiac, L-tyrosine, phenol, tannic acid agar, and syringaldazine tests negative.

NOBLE'S KEY CODES: 1.6.7.36.38.47.

CULTURES EXAMINED: CBW-1996.

DISCUSSION. Cultures of this taxon differ from those of *X. affine* in several ways. Mycelial mat reverse color is cream in *X. affine* but white in *X. affine* var. *maculosum*. Three color zones under UV light are evident in *X. affine* var. *maculosum* while two zones are evident in *X. affine*. Vesicular swellings are present in *X. affine* but absent in *X. affine* var. *maculosum*. Clearly there are differences between the two varieties of this taxon but the cultural differences do not appear significant enough to elevate this taxon to specific rank.

Xanthoconium montaltoensis Wolfe. 1987. Can. J. Bot. 65: 2143.

FIGS. 3, 7

MACROSCOPIC CHARACTERISTICS: Mycelial mat 5.4-6 cm diam., surface cream white, reverse pale cream yellow (3,4A2), pigment diffusion into agar absent, zonate inner 1 cm, surface heterogeneous, hyphae mostly submerged, aerial hyphae few, surface exudates none; yellow-green on submerged outer zone, light yellow on middle zone, and dingy purple to violet on inner zone under UV light.

MAT MICROCHEMISTRY: $FeSO_4$ positive, yellow-green; NH_4OH and HCl negative.

MICROSCOPIC CHARACTERISTICS: Hyphae (2.6-)4.2(-5.2) μm diam., pale yellow in KOH, gold to dark gold in Melzer's reagent, cytoplasm blue and walls hyaline in cotton blue, dikaryotic, inner zone vesicular hyphae (7.8-) 14(-20.8) μm diam. and mostly non-septate, branching subseptal and interseptal; cytoplasm lipid positive, black in Sudan Black-B and red in Sudan IV, lipoidal bodies sparse in Sudan IV but more dense in Sudan Black-B.

EXTRACELLULAR OXIDASE TESTS: guaiacol, gum guaiac, and L-tyrosine, phenol, syringaldazine, and tannic acid agar negative.

NOBLE'S KEY CODES: 1.6.26.32.36.38.47.49.53.56.

CULTURES EXAMINED: CBW-1675.

DISCUSSION. Mature basidiomata of *Xanthoconium montaltoensis* and *X. affine* may appear similar but cultures of these taxa differ by the absence of positive guaiacol and phenol spot tests in the former. Additionally, the inner zone of the mycelial mat in *X. affine* is ocher-green under UV light while the inner zone of *X. montaltoensis* is dingy purple to violet under UV light. The zonate patterns and the vesicular hyphae are similar for both species. The cultural character differences observed for these species provide additional support for the recognition of *X. montaltoensis*.

Xanthoconium montanum Wolfe. 1987. Can. J. Bot. 65: 2144.
FIGS 4, 8

MACROSCOPIC CHARACTERISTICS: Mycelial mat 3.1-4.5 cm diam., surface white, reverse pale yellow (4A2), pigment diffusion into agar absent, uniform, zonation absent, aerial hyphae well developed, fluffy, cottony, surface exudates absent, yellow-green overall under UV light.

MAT MACROCHEMISTRY: $FeSO_4$ positive, yellow-green; NH_4OH and HCl negative.

MICROSCOPIC CHARACTERISTICS: Hyphae (2.6-)4.4(-9.1) μm diam., hyaline in KOH, pale gold in Melzer's reagent, cytoplasm blue and walls hyaline in cotton blue, dikaryotic, subseptal branching only; cytoplasm lipid positive, black in Sudan Black-B, pink to purple-red in Sudan IV, lipoidal bodies mostly small (rarely large), spherical, singular or in staphylococcal form.

EXTRACELLULAR OXIDASE TESTS: phenol positive, vinaceous purple; guaiacol, gum guaiac, tannic acid agar, L-tyrosine, and syringaldazine negative.

NOBLE'S KEY CODES: 1.6.7.32.36.38.47.49.56.

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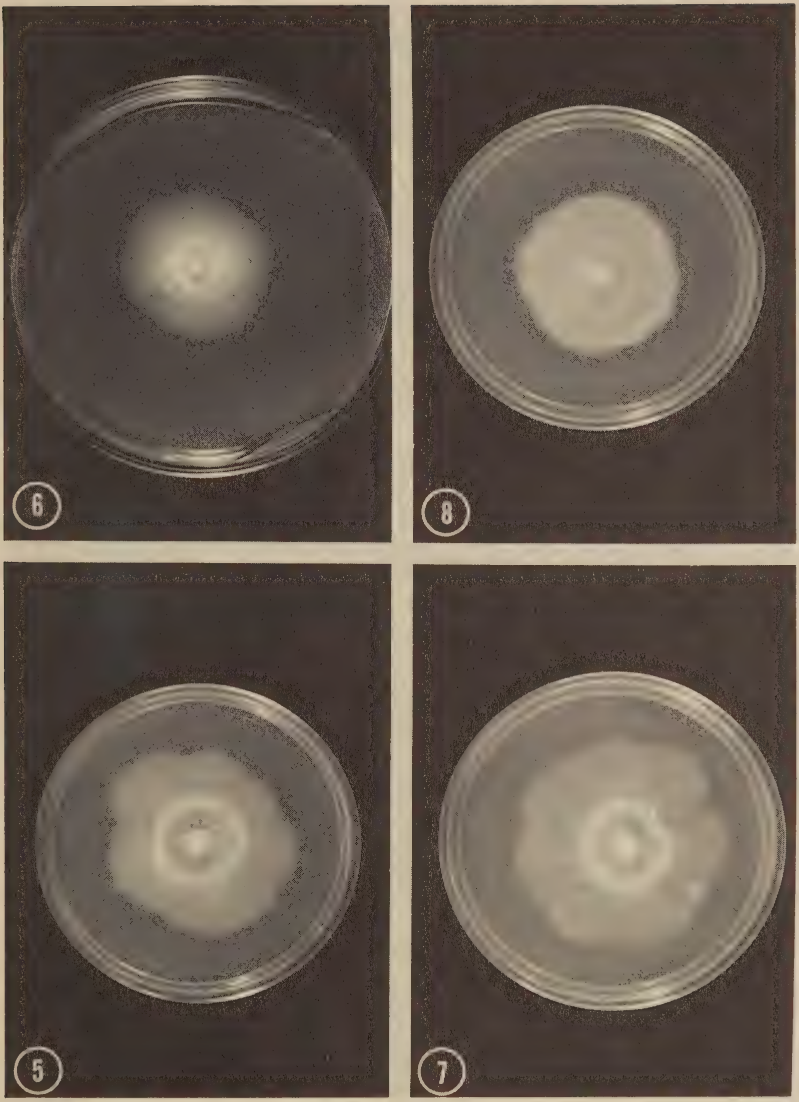

Figs. 5-8. Cultures of *Xanthoconium* species. Fig. 5. *X. affine*. Fig. 6. *X. affine* var. *maculosum*. Fig. 7. *X. montaltoensis*. Fig. 8. *X. montanum*.

CULTURES EXAMINED: CBW-1489 (HOLOTYPE).

DISCUSSION. The cultural characteristics of this taxon were relatively unremarkable except for the abundant aerial hyphae development, and there was little hyphal differentiation. The lipoidal bodies in the hyphae were remarkable in that they occurred in staphylococcal form.

ACKNOWLEDGEMENTS

I would like to extend my appreciation to Dr. Orson K. Miller, Jr. for his critique of this manuscript, to Dr. Richard C. Bruce, Executive Director of The Highlands Biological Station, Inc., Highlands, North Carolina for a grant-in-aid, to The Commonwealth Educational System of The Pennsylvania State University for the Faculty Scholarship Support Fund grant, and to Mr. Robert Morgan for his assistance in the maintenance of the culture collection during the course of these studies.

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HYPHOMYCETES FROM CANADIAN STREAMS.
II. THREE NEW TAXA

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Abstract

Miniancora allisoniensis gen. et sp. nov., *Arborispora paupera* sp. nov. and *Flagellospora saccata* sp. nov. are described from acid streams in Canada.

Introduction

This is the second part of a study on freshwater hyphomycetes isolated from soft water streams in SE New Brunswick, Canada, and adjacent areas of Nova Scotia. Three new taxa were isolated from foam. A single conidium of *Miniancora allisoniensis* was observed during the original field study (April - May 1987); subsequently, morphologically identical conidia were observed repeatedly in the autumn of 1988. Conidia of *Arborispora paupera* were found on two occasions in Allen Creek. *Flagellospora saccata* appears to be the most common of the three species. It was isolated from three localities, and conidia indistinguishable from *F. saccata* were moderately abundant in foam samples.

Materials and Methods

All cultures were obtained as monoconidial isolates from freshly collected stream foam, as described by Marvanová & Bärlocher (1988). They were maintained on 1.5 % Difco Malt Agar (MA) at 10 or 12 °C. Sporulation was induced by submerging a section of the culture in standing or aerated distilled water; in *Arborispora paupera* intermittent wetting of the culture resulted in abundant sporulation.

Miniancora Marvanová et Bärlocher, gen. nov.

Etym.: mini: abbreviated from *minimus* (L.) = smallest; *ancora* (L.) = anchor.

Deuteromycetes, Moniliales. Hyphae hyalinae, ramificatae, septatae. Conidiophora singularia, plerumque apicalia, simplicia vel ramosa, hyphis valde similia. Cellulae conidiogenae incorporatae, mono vel polyblasticae, sympodialiter prolificantes, cum collari inconspicuo. Conidia T-formia, septata, cellula apicalis cum ramis duobus dichotomis, in maturitate vacua.

Species typica: *Miniancora allisoniensis*

Hyphae hyaline, branched, septate. Conidiophores single, mostly apical, simple or branched, flexuous. Conidiogenous cells integrated, mono to polyblastic, sympodial, with inconspicuous frill. Conidia T-shaped, septate, apical cell typically divided into two dichotomous branches, empty when mature.

Miniancora allisoniensis Marvanová et Bärlocher, sp. nov. (Figs. 1-3).

Etym.: *allisoniensis* (L.) to mark the sesquicentennial of Mount Allison University, where this study was carried out.

Coloniae aurantiacae, in agaro maltoso lente crescentes, restrictae, mycelium aerium delicatum, pubescens, subtiliter funiculosum in parte centrali coloniae; hyphae hyalinae, tenuitunicatae, 1-2 µm diam.; mycelium in agaro e hyphis densiter consertis, nonnumquam crustas formantibus, usque ad 3.5 µm latis, crassitunicatis, cum materia amorpha aurantiaca obtectis. Conidiophora apicalia vel lateralia, simplicia vel ramosa, usque ad 1.5 µm lata, nonnumquam absentia. Cellulae conidiogenae apicales, raro intercalares in hyphis, singulares, typice polyblasticae, cum elongationibus sympodialibus provisae, loci conidiogeni vulgo cum collari inconspicuo circumdati. Conidia singulatim formata, saepe aggregata, acrogena, raro pleurogena, T-formia; pars infra ramos recta vel paulo curvata, 23-40 x 1-1.5 µm, e 3-6 cellulis lucidis composita, basi truncata vel conica, apice attenuata, cellula apicalis in maturitate vacua, cum ramis duobus dichotomis, acutis, 9-23 x 0.5 µm, horizontalibus vel subantrorsis, pariete exiliter sinuoso.

Habitat: In spuma in rivulo parvo prope viam publicam haud procul a pago Sackville dicto, in provincia New Brunswick, Canada austro-orientalis. In Maio 1987 leg. L. Marvanová.

Holotype: IMI 328552 (ex 30487)

Colonies (Malt Extract Agar = MA) orange, growing slowly, 10 µm diam./30 days/12 ^{0} C, restricted, tough; aerial mycelium delicate, downy, finely funiculose in the colony centre, hyphae hyaline, thin-walled, 1-2 µm wide; substrate mycelium consisting of densely packed hyphae sometimes forming crusts, up to 3.5 µm wide, thick-walled, covered with amorphous orange matter. Sporulation abundant on agar and in standing water, at and below water level. Conidiophores densely covering the colony surface, apical or lateral, simple or branched, up to 1.5 µm wide, sometimes absent. Conidiogenous cells apical, rarely intercalary in vegetative hyphae, single, typically polyblastic, elongations

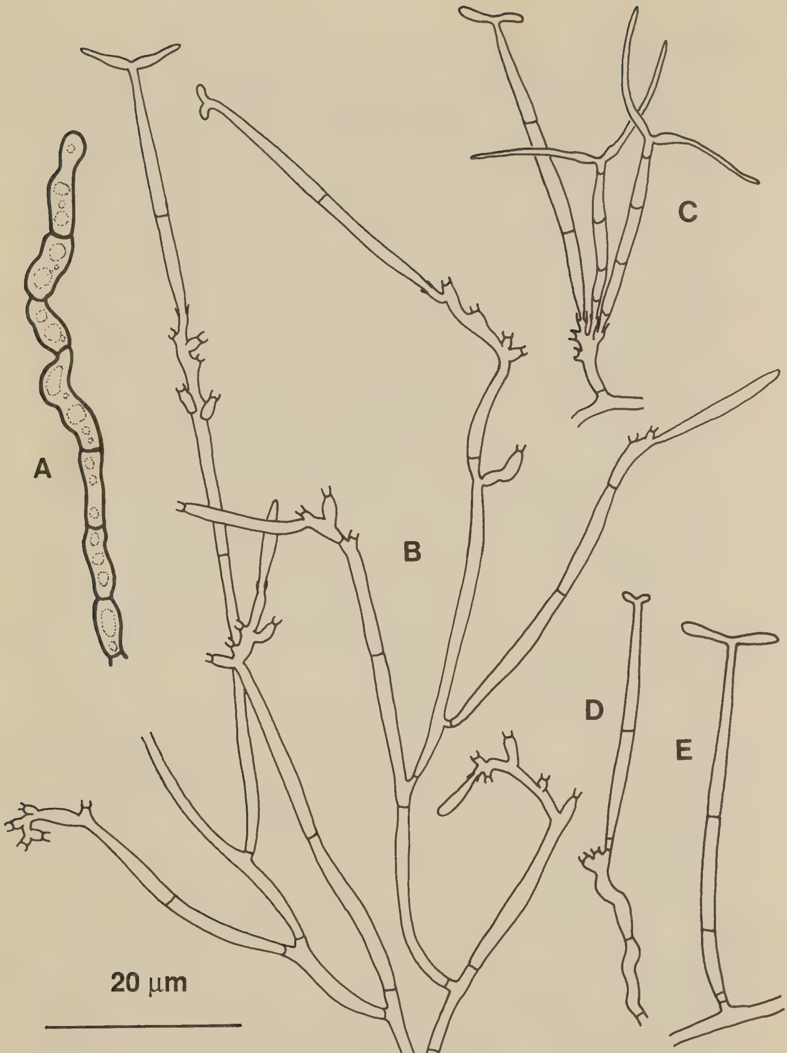


Fig. 1. *Miniancora allisoniensis,* 30487, submerged culture. A, substrate mycelium with inflated cells; B, branched conidiophore with sympodial elongations and frilled conidiogenous loci; C, short conidiophores with aggregated condidiogenous loci; D,E, developing conidia with separating cells (?) at the base.

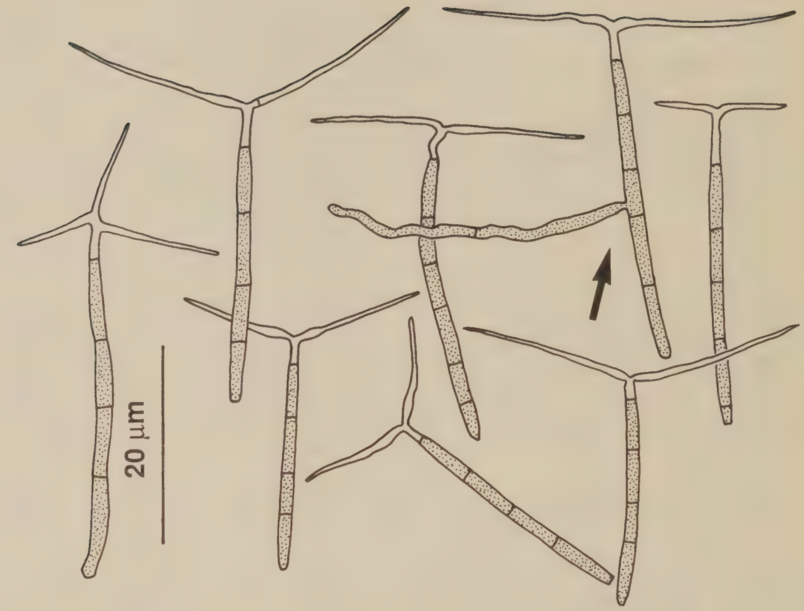


Fig. 2. *Miniancora allisoniensis*, 30487, submerged culture. Detached conidia, one germinating from the axis (arrow). Dotted parts are filled with cytoplasm.

sympodial, often unilateral, forming short branchlets (Fig. 1B) or appearing side by side on a thickened part of the conidiogenous cell (Fig. 1C); conidiogenous loci usually surrounded by an inconspicuous frill. Conidia formed singly, later aggregated, acrogenous, rarely pleurogenous, T-shaped or very rarely with an apical branch and two laterals (Fig. 2A), unbranched part straight or slightly curved, 23-40 x 1-1.5 µm, consisting of 3-4 shiny cells; truncate or shortly conical at the base, narrowed at the apex below the branches; apical cell devoid of cytoplasm at maturity, divided into two horizontal dichotomous branches attenuated distally, 9-23 x 0.5 µm, with slightly wavy outline. The conidial size seems to change with age; smaller conidia (23-33 µm long) were seen in a culture submerged for 4 days, whereas longer conidia (30-40 µm) prevailed in the same dish after 14 days. The conidial branches are cellular (sensu Sutton 1980) in origin and are filled with cytoplasm during maturation; evacuation takes place before secession.

The actual type of conidiogenesis could not be established with certainty. The thin frills around the conidiogenous loci may either be collarettes of phialides or wall remains of disarticulated separating cells. Structures resembling separating cells were seen

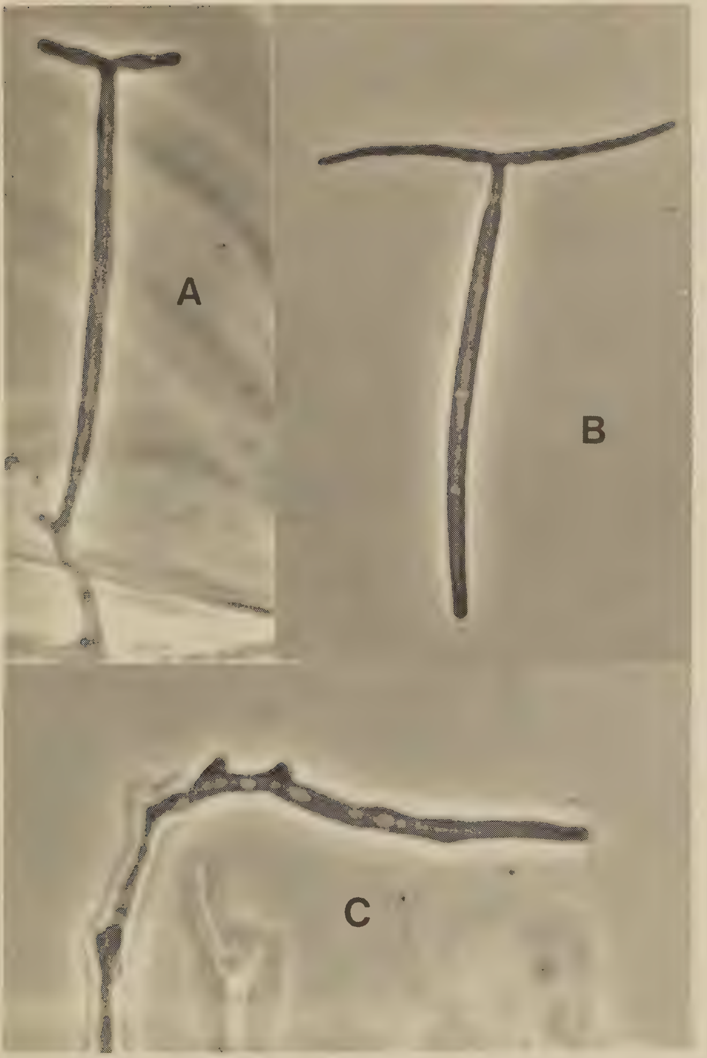


Fig. 3. *Miniancora allisoniensis*, 30487. A, developing conidium; B, detached conidium; C, spent conidiophore (approx. 1,850 x).

at the base of some developing conidia (Fig. 1 D, E), however, the corresponding cell wall remnants which should be present at the conidial bases in the case of rhexolytic secession could not be detected with light microscopy. On the other hand, some conidia appeared to have a collarette around their base when still attached (Fig. 1 B, C). This would support the hypothesis of a phialidic conidiogenesis.

On agar and at 20 ° C, detached conidia germinated within 24 h from any cell of the unbranched part and occasionally from the branches.

Cultures examined: 30487, from a small unnamed stream near the Trans Canada Highway near Sackville, May 1987, isol. L. Marvanová.

The conidia of this fungus are similar to those of *Trinacrium* Hoehnel. The latter, however, are mostly Y-shaped and wider, and all their cells are filled with cytoplasm. Conidiogenous cells with frills have not been reported in any species of this genus. *Hyalotiella americana* (Speg.) Nag Raj as well as *Libartania laserpitii* (Bresad.) Nag Raj have conidia of similar size with two (dichotomous) or more apical branches. However, both taxa are pycnidial coelomycetes. The conidiogenous cells are asynchronously polyblastic in *Libartania laserpitii* and symmpodially proliferating in *Hyalotiella americana.* Frills have not been reported or illustrated in either of the two species (Nag Raj 1979 a,b).

Arborispora paupera Marvanová et Bärlocher, sp. nov. (Figs. 4, 5, 6 C, D)

Etym.: *pauper* (L.) = poor (refers to the simple branching of conidia)

Coloniae in agaro maltoso perleniter crescentes, restrictae, pallidae, postea brunneae, praecipue in agaro immersae, glabrae vel valde rugosae, mycelium aerium sparsum, funiculosum, hyphae tenui tunicatae circa 1 µm latae, hyalinae, ramificatae, rami alternati vel subоppositi. Cellulae inflatae usque ad 2.5 µm latae adsunt in hyphis. Conidiophora inconspicua vel absentia. Cellulae conidiogenae incorporatae, per longitudinem hypharum dispersae vel in hyphis fertilibus catenatae; loci conidiogeni in denticulis lateralibus singulis vel gregariis 1-2 µm longis, interdum ex inflatione hyphae ecrescentibus, locati. Conidia singularia vel aggregata, in denticulis singulatim crescentia, typice tetraradiata; axis rectus, raro curvatus, (20-) 40-70 x 1.8-2.5 µm, cylindricus vel anguste fusoideus, basi truncatus, apice subulatus, usque ad 8-septatus; rami (0)1-2(4), usque ad 4-septati, typice oppositi vel subоppositi, raro remoti, 10-35 x 1.5-2 µm, prope partem centralem axis inserti, typice retrorsi, recti vel paulo curvati, anguste fusoidei, in parte proxima interdum inflati, basi gradatim angustati, insertione constricti. Ramus secundarius rarissime videtur. Dehiscentia conidiorum schizolytica.

Habitat: In spuma in rivulo acido Allen Creek dicto, prope locum Wood Point, in provincia New Brunswick, Canada austro-orientalis, in Aprili 1987 leg. L. Marvanová et F. Bärlocher.

Holotype: IMI 328550 (ex 28387)

Colonies (MA) growing extremely slowly, 2-4 mm diam./30

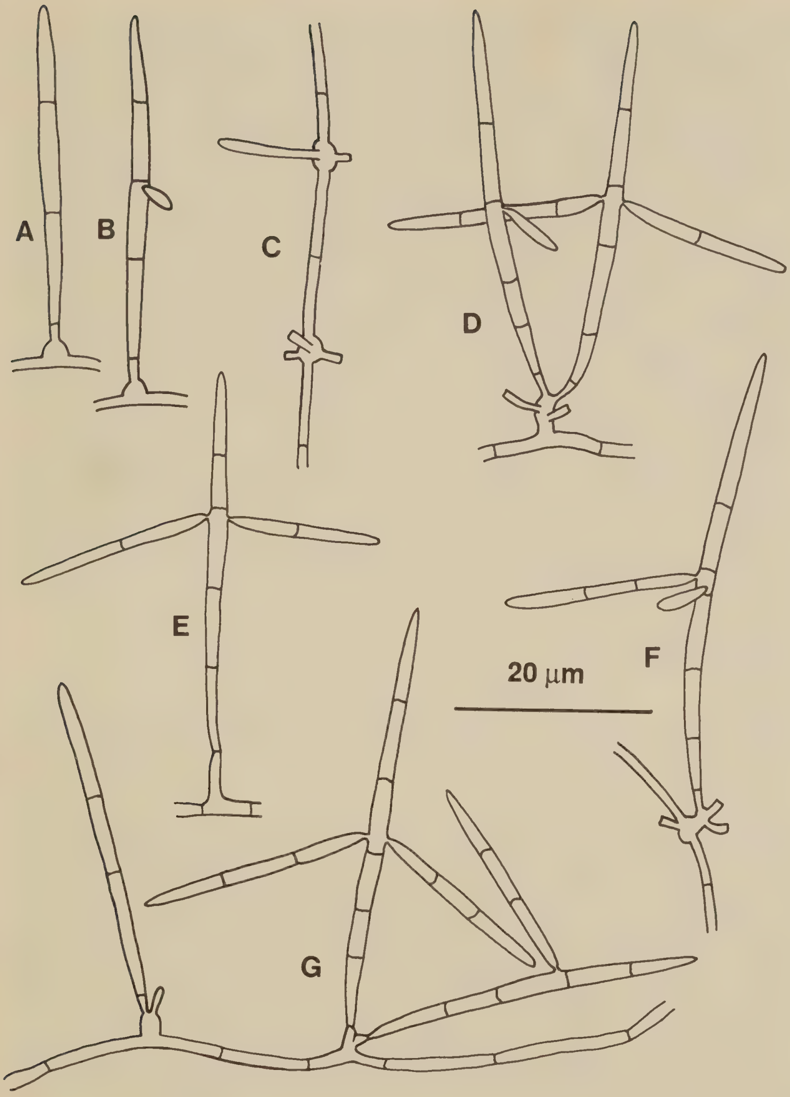

A
B
C
D
E
F
G
20 µm

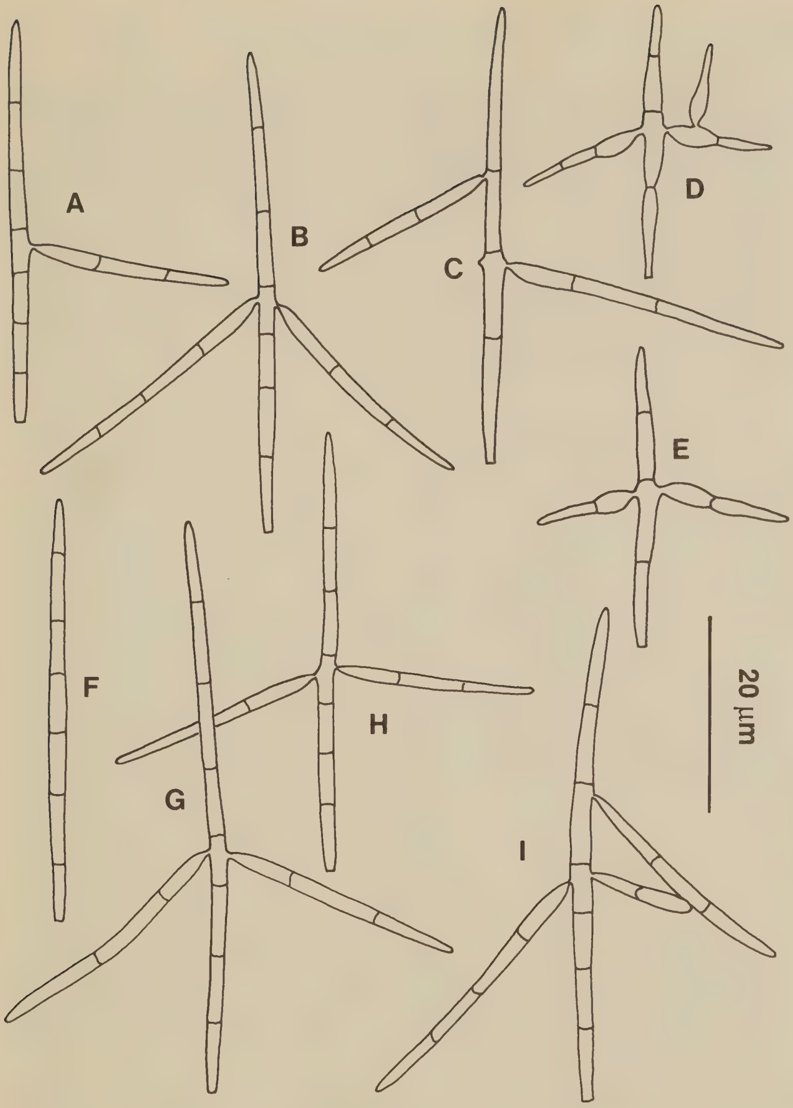
Fig. 4. *Arborispora paupera*, 28387. Developing conidia. Detailed explanation in text.

days/10-12 ^{o} C, restricted, beige, becoming brownish with age, smooth or wrinkled, mostly immersed in agar; aerial mycelium sparse, funiculose. Hyphae thin-walled, ca. 1 µm wide, hyaline, branched, branches alternate or subopposite. Inflated cells up to 2.5 µm wide may occur in hyphae. Sporulation upon submergence, but above water, promoted by intermittent wetting. Conidiophores micronematous; conidiogenous cells integrated, intercalary, scattered or catenate in a fertile hypha, with conidiogenous loci on single or multiple denticles situated laterally on conidiogenous cells (Fig. 4 A, B, E) or on a short stalk (Fig. 4 D, F, G) or growing from a central inflation on the conidiogenous cell (Fig. 4 C). Conidia are formed singly, the primordia are rod-like, straight, later delimited by a septum situated 1-2 µm above the base of the primordium; the lower part becomes the denticle (Fig. 4 A). Branches appear laterally, in sequence, ca 15-18 µm below the apex of the axis (Fig. 4 B). Free conidia floating on water surface, axis straight, rarely slightly curved, (20-) 40-70 x 1.8-2.5 µm, cylindrical or narrowly fusoid, base truncate, apex subulate, septa up to 8; branches (0)1-2(4), up to 4-septate, opposite or nearly so (Fig. 5 B, E, G, H), sometimes both on one side (Fig. 4 F), rarely remote (Fig. 5 C) or in two superposed pairs, sometimes two opposite and one remote (Fig. 5 I), 10-35 x 1.5-2 µm, one usually shorter, inserted near the middle of the axis, narrowly fusoid with basal cells sometimes inflated, gradually tapering towards the point of attachment. On rare occasions, a secondary branch may be present (Fig. 5 D). Conidial secession schizolytic, germination from all free ends, on agar or in water.

Culture examined: 28387, from Allen Creek, April 1987, isol. L. Marvanová.

Conidia very similar to those of our species but with dimensions near the lower limit of *A. paupera* and with branches drawn antrorse are depicted as unknown by Matsushima (1975, Pl. 336, Figs. 2, 4).

Arborispora Ando (Ando & Kawamoto 1986) was established for three staurosporous species collected in humid habitats: from fallen leaves or from rainwater draining from a broad-leaved tree. They all grow rather slowly in pure culture (Miura & Kudo 1970); sporulation is promoted by submerging a piece of the culture in distilled water but occurs predominantly on exposed areas above water; the conidia are borne on micronematous conidiophores and consist of an axis and branches originating laterally near the middle of the axis. Branches may be primary, secondary, or, in the authors' words "second primary", i.e., originating near the point of attachment of the so called "first primary branches". All branches have tapering bases with a very narrow insertion point. The proximal cells of the branches and, in some species, of the axis may be slightly inflated. *A. paupera* is linked to other species of this genus by several features: The very slow growth of the colony resembles *A. multisurcularis* Ando and *A. dolichovirga* Ando; the brownish colour of the colony is shared by *A. multisurcularis*; the conidial dimensions approximate those of *A. dolichovirga*; the occasionally inflated basal cells of the branches and axis resemble those seen in *A. palma* Ando. *A. paupera* differs from all other


A
B
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20 µm

Fig. 5. *Arborispora paupera*, 28387. Detached conidia. Detailed explanation in text.

species of this genus by the lack of second primary branches and by the predominantly retrorse orientation of the laterals. The degree of branching in staurosporous anamorph genera usually varies within a genus from simple to more profuse. Examples can be found in *Dendrospora* Ingold, *Tricladium* Ingold, and *Gyoerffyella* Kol. *Descalsia cruciata* Roldán et Honrubia (sp. ined., Roldán in litt.) has cruciform conidia of similar size borne on micronematous conidiophores. However, the conidial branch bases are not constricted, the branches arise synchronously and subapically in contrast to their clearly lateral and sequential origin in *A. paupera*. This species is probably adapted to habitats that periodically dry up. Conidia matching the shapes seen in the field were obtained by briefly exposing a piece of culture to dry conditions. Under constantly moist conditions, the culture did sporulate on the area outside the water, but the conidia were much smaller and their branches, sometimes also their axis, had inflated basal cells (Fig. 5 D, E).

Flagellospora saccata Marvanová et Bärlocher, sp. nov. (Figs. 6 A, B; 7, 8).

Etym.: *saccatus* (L.) = bag-shaped, refers to the phialides.

Coloniae in agaro maltoso leniter crescentes, albidae, glabrae vel subtiliter pubescentes, densae, hyphae 1-2 µm latae, margine coloniae undulatae; cellulae inflatae, tenuitunicatae, catenatae, usque ad 5 µm latae, in parte senescente coloniae observantur. Conidiophora singularia, apicalia vel raro lateralia, usque ad 75 µm longa, simplicia vel parce ramosa, saepe modo vario flexa, septata, cellulis saepe inflatis; nonnumquam absentia. Cellulae conidiogenae phialidicae, singulares vel binae, apicales, laterales vel raro intercalares, saepe curvatae, inflatae et nonnumquam asymmetricae, 7-20 x 3-5 µm, cum collo 2-5 µm longo, interdum recurvo; collare breve, cylindricum vel infundibuliforme, inconspicuum. Conidia singularia, apicalia vel lateralia ubi e phialidis intercalaribus ecrescentia, filamentosa, sigmoidea vel arcuata, basi et apice attenuata, (35-)55-87 x 1.8-2.5 µm, ex eodem loco repetiter crescentia, 3-8 septata. Dehiscentia schizolytica.

Habitat: In spuma in rivulo acido St. George Creek dicto, haud procul a loco Fenwick dicto, in provincia Nova Scotia, Canada austro-orientalis; in Aprili 1987 leg. L. Marvanová et F. Bärlocher.

Holotype: IMI 328551 (ex 18987)

Colonies (MA) whitish to creamy, growing very slowly, restricted, 9 mm diam./30 days/10 °C, glabrous or very finely downy, tough, hyphae 1-2 µm wide, marginal hyphae typically undulate even when growing in water; inflated thin-walled cells (Fig. 7 F, H) up to 5 µm diam., catenate, appear in hyphae in older parts of the colony. Sporulation sparse after 8 days in standing distilled water at 10 °C, underwater. Conidiophores apical, rarely lateral, simple or sparsely branched, often variously curved, up to 75 µm long, septate, often with slightly inflated cells; sometimes absent. Conidiogenous cells phialidic, single or paired, apical, lateral or intercalary, sometimes with a lateral conidiogenous locus (Fig. 7 A, F); asymmetrically inflated and often slightly curved, 7-20 x 3-5 µm, with a 2-5 µm long, occasionally recurved neck (Fig. 8 I, J) with periclinal thickening and a short, cylindrical or cup-shaped

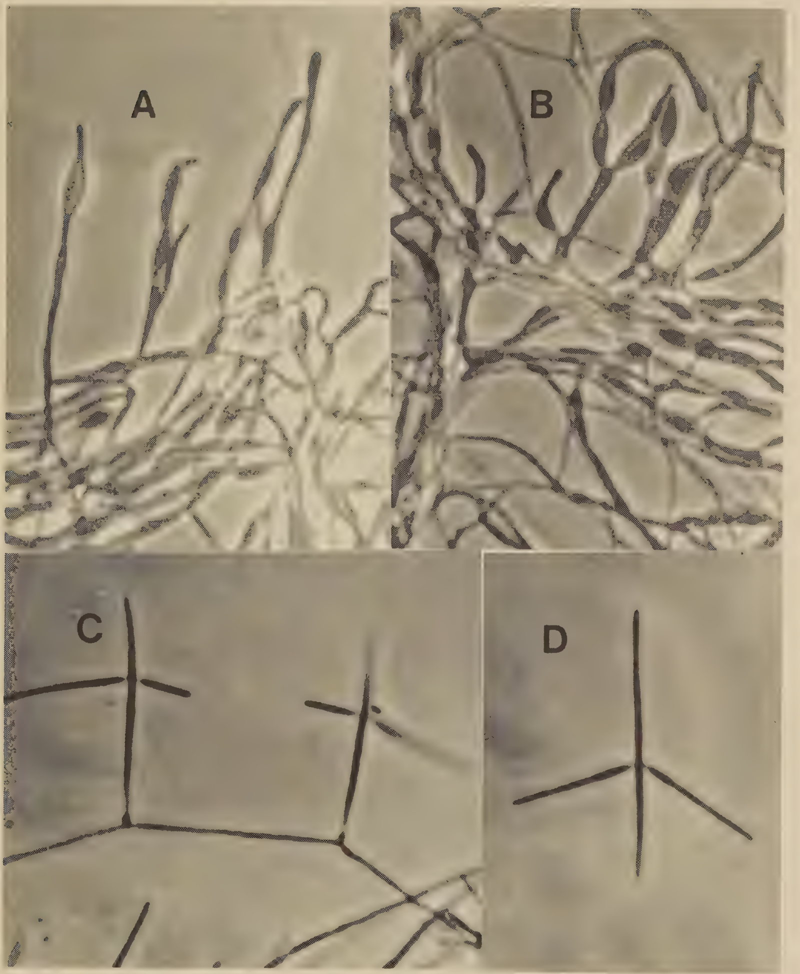

Fig. 6. *Flagellospora saccata*, 18987. Submerged culture. A, D, E, G, developing conidia; B, young phialides; C, F, conidiophores with spent phialides; F, H, chain of inflated cells.

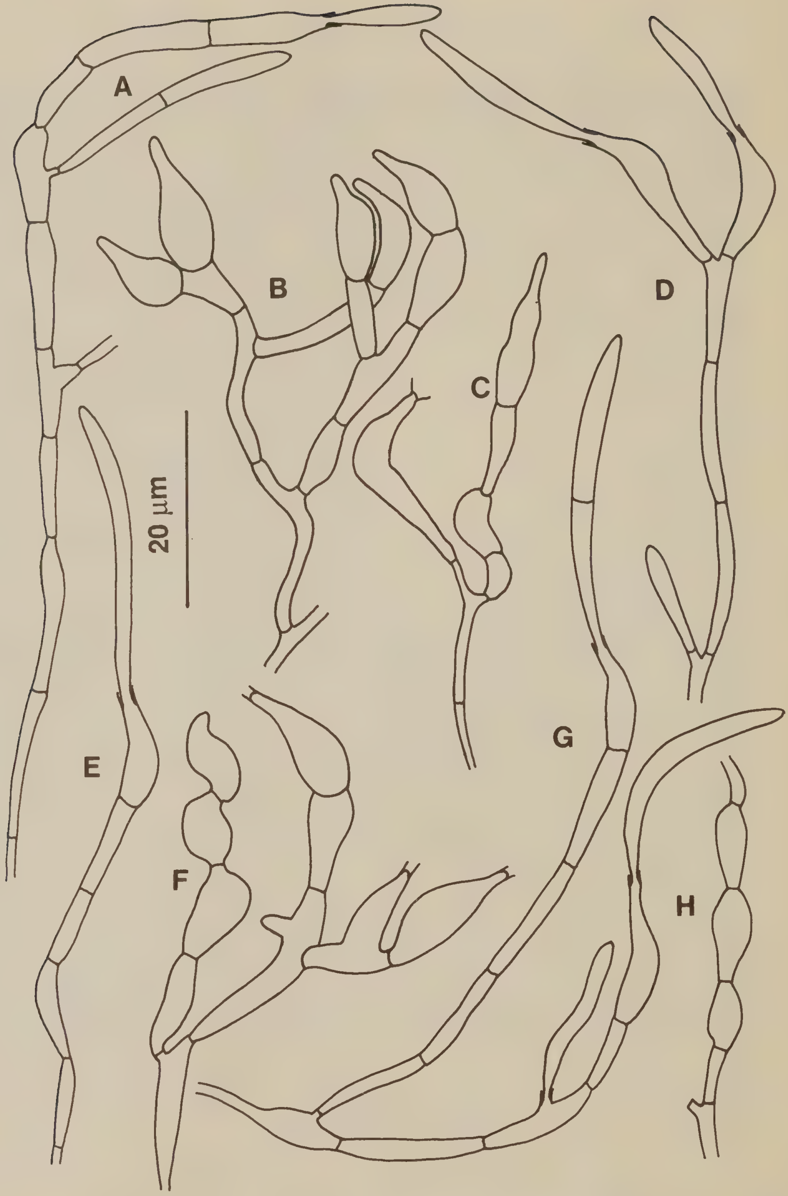
A
B
C
D
20 µm
E
F
G
H

Fig. 7. *Flagellospora saccata,* 18987. Submerged culture. A-H, condidia; I-M, spent phialides.

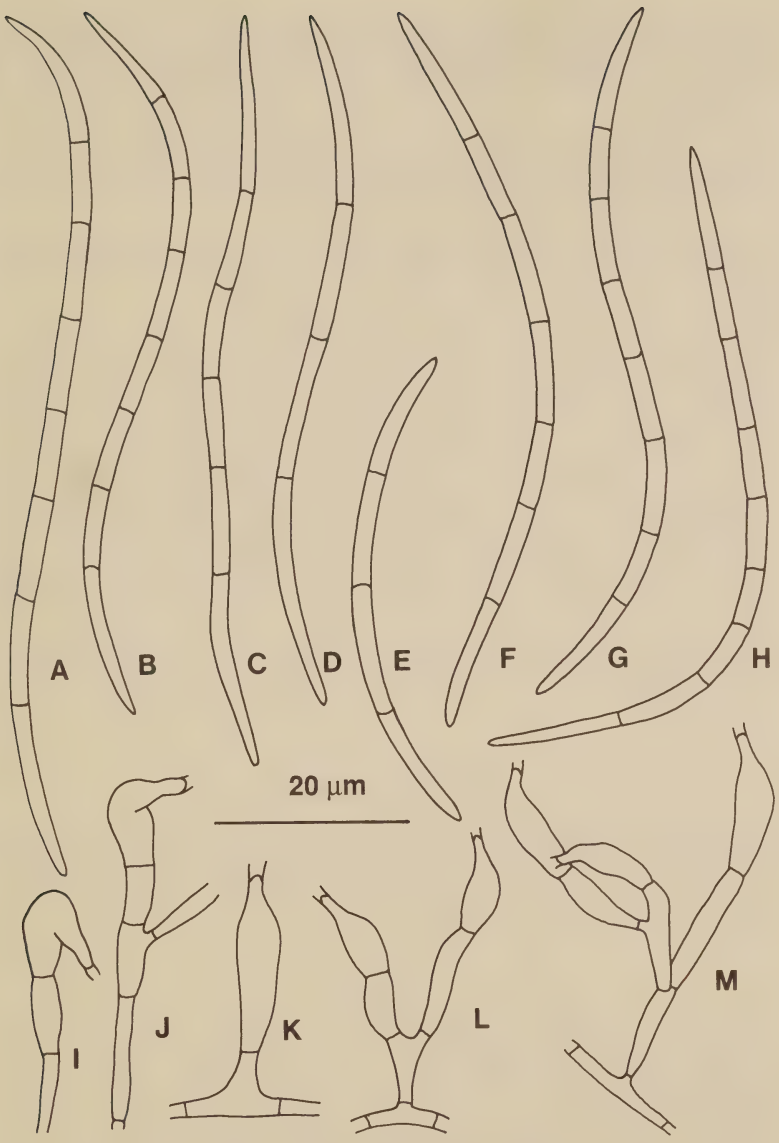
A
B
C
D
E
F
G
H
20 μm
I
J
K
L
M

Fig. 8. A, B, *Flagellospora saccata*, 18987. Inflated phialides with long necks; approx. 600 x. C, D, *Arborispora paupera*, 28387. C, developing conidia; D, detached conidia; approx. 860 x.

collarette. Conidia single, apical, rarely lateral, when produced on intercalary phialides, filamentous, sigmoid or arcuate, attenuated towards both ends, (35-)55-87 x 1.8-2.5 µm, septa 3-8 (Fig. 8, A-H). Secession schizolytic, germination from both ends in water and on agar.

The morphology of the conidiophore stalks indicates that they may consist of proliferated phialides; the presence of lateral necks on some phialides supports this view.

Cultures examined: 13887, 18987, from St. George Creek, Nova Scotia, April 1987, isol. L. Marvanová; 22287, from Allen Creek, New Brunswick, April 1987, isol. L. Marvanová.

There are six described species in *Flagellospora*: two with conidia up to ca. 120 µm long (*F. curvula*, Ingold 1942 and *F. leucorhynchos*, Marvanová1986), three with conidia up to 55 µm long (*F. minuta*, Iqbal & Bhatty 1980, *F. penicillioides,* Ingold 1944 and *F. stricta,* Nilsson 1962) and one with conidia of dimensions matching our new species (*F. fusarioides,* Iqbal 1974). The latter, however, differs by having darker, almost cinnamon-coloured colonies and profusely penicillately branched conidiophores with more numerous (up to 5) phialides per branch. The main feature distinguishing our new species from all *Flagellospora* spp. is the presence of apparently inflated, long-necked phialides, which clearly differ from the slender structures, mostly without collarette and periclinal thickening, known from the other species.

The other waterborne conidia of similar size and shape are not produced by phialidic conidiogenous cells. It is almost impossible to identify *F. saccata* reliably on the basis of loose conidia from field samples.

Acknowledgements

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DISCOSIOSPORA CEANOTHI, A NEW COELOMYCETE

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In October, 1987, living leaves of *Ceanothus fendleri* Gray were collected and stored under moist conditions in a refrigerator until March, 1988. A new Coelomycete with 4-celled, appendaged conidia was found on the leaves. The fungus was isolated onto potato dextrose agar (PDA) for study in culture.

Discosiospora gen. nov.

Conidiomata pycnidia, separata vel interdum confluentia, subepidermalia, emergentia, aliquantum globosa depressa, brunnea, unilocularia, ostiolata; paries ex textura angulari tenuipariete compositus. Conidiophora absentia. Cellulae conidiogenae holoblasticae, determinatae, discretae, terminales, cum conidio singulari terminali. Conidiogenesis primum in conidioma summa, tum in conidioma ima reperta. Conidia dorsiventralia, tenuiparietes, tetracellulae, cellula apicalis et basalis setam subapicalem et suprabasalem insertam in latere concavo conidii ferens, appendix basalis exogena.

Sp. typ. D. ceanothi Ramaley

Conidiomata pycnidial, separate or occasionally confluent, subepidermal, emergent, somewhat depressed globose, brown, unilocular, ostiolate; wall composed of thin-walled textura angularis. Conidiophores absent. Conidiogenous cells holoblastic, determinate, discrete, terminal, with a single terminal conidium. Conidiogenesis found first at the top, then the base of the conidioma. Conidia dorsiventral, thin-walled, 4-celled, the apical and basal cell bearing a subapical and suprabasal appendage inserted on the concave side of the conidium; basal appendage exogenous.

Other genera with 4-celled conidia bearing appendages on both terminal cells include *Doliomyces* Steyaert *emend* Nag Raj & Kendrick (1), *Seimatosporium* Corda (2,3,6), *Seimatosporiopsis* Sutton, Ghaffar & Abbas (7), *Discosia* Libert(4), and *Ciliochorella* Sydow (5). Four of these genera may be easily separated from *Discosiospora*. *Ciliochorella* has phialidic conidiogenesis, an apical and a lateral appendage on the apical cell, and a single appendage on the basal cell. *Seimatosporium* has acervular conidiomata, annellidic conidiogensis, and the number and branching of the conidial appendages is variable and irregular. *Seimatosporiopsis* has immersed pycnidial conidiomata, conidiogenesis is annellidic, and the number and branching of conidial appendages is variable. *Doliomyces* has non-ostiolate, black, pycnidial conidiomata, and each conidium has a several-branched apical appendage, a simple basal appendage, and different sized middle cells. In addition, all these genera have thicker conidial appendages than does *Discosiospora*. The relationship of *Discosiospora to Discosia* must be considered in greater detail because conidia of the two genera are similar, and distinct from conidia of other taxa.

Discosiospora has a composite of the characters used by Subramanian and Chandra-Reddy to separate sections of *Discosia* (4). The middle cells of *Discosiospora* conidia are of more or less equal length, as is true in *Discosia* of Section III. The hair-like appendages of *Discosiospora* arise from a tiny bulge at approximately the middle of the terminal cells (Fig. 1. c,e). The appendages of *Discosia*, Section I, usually originate from a minute bulge near the septa on both ends of the conidium, while those of Sections II-IV, originate just below the apices of the end cells.

Subramanian and Chandra-Reddy (4) provide a generic description for *Discosia* including statements that: conidiomata are usually amphigenous, black, discoid; upper half sterile, brittle, and the lower half fertile; vertical columns of sterile hyphae usually present extending from base to top all round the margin or also in between, dividing the pycnidial cavity into compartments. It is also stated (4, p. 60) that in his study of conidium development and conidiogenous cell behavior, Morgan-Jones found a conidiogenous cell bore 2 conidia. After release of the first conidium, formed from the blown out apex of a conidiogenous cell, a second conidium was formed at a higher level resulting in one annellation. A minute frill was seen at the base of the conidium with phase contrast optics. In many cases, however, he noted only one conidium developed on each conidiogenous cell.

Discosiospora differs from *Discosia* in many characteristics included in the generic description. Conidiomata: are (a) epiphyllous in this single collection, (b) brown, (c) subglobose, and, (d) fertile over the entire inner surface successively from top to bottom; (e) have a soft, not brittle upper surface, and; (f) lack vertical columns of sterile hyphae from base to top. In addition, *Discosiospora* is distinguished from most Coelomycetes, including *Discosia*, by its possessing paraphyses or paraphysis-like outgrowths in areas where conidium formation is complete.

Conidial ontogeny, a major taxonomic consideration, also separates *Discosiospora* from *Discosia*. The annellophores in *Discosia* usually bear 2 conidia, the second at a higher level than the first, resulting in conidiogenous cells with one annellation (4). No annellations were seen on the conidiogenous cells of *Discosiospora*. A minute ridge was present on the basal cell of some spores.

T. R. Nag Raj (personal communication), has illustrated *Discosia* species (unpublished) with some characters that have been used here to distinguish *Discosiospora*--the presence of non-discoid conidiomata, and conidiomata bearing conidia over the entire surface of the conidiomatal cavity. However, the illustrations show annellidic conidiogenesis, sometimes on branched conidiophores. The existence of these taxa with some characteristics of both *Discosia* and *Discosiospora* suggests *Discosiospora* may eventually best be treated as a species of *Discosia*. Such a treatment may be preferred when additional intermediate taxa allow expansion of the generic concept to include forms with (a) conidiomata which are epiphyllous or amphigenous, brown or black, subglobose or discoid, soft or brittle, and paraphysate or aparaphysate, (b) conidiogenesis that is annellidic or holoblastic with one conidium per conidiogenous cell, and, (c) discrete or integrated conidiogenous cells on all surfaces of the conidiomatal cavity or only on the bottom surface. With the present generic concept, it would seem preferable to separate *Discosiospora* from *Discosia*.

Discosiospora ceanothi sp. nov. (Fig. 1, a-f)

Conidiomata pycnidia, epiphylla, separata vel interdum confluentia, subepidermalia, emergentia, in juventa complanata, extrinsecus per crescentiam expansa, aliquantum matura sublobosa, unilocularia, ostiolata, juvena diluto fulvo, atrobrunnea circum ostiolum evolvens, gradatim brunnescentes per maturationem ex ostiolo ad basem, usque ad 320 *µm diam, plerumque* 170-220 *µm; ostiolum parvum, singulare, circulare, papillatum, centrale vel excentricum* 10-15 *µm diam; paries ex textura angulari tenuipariete compositus,* 6-8 *cellulis crassis supra,* 4-6 *cellulis crassis infra. Cirri diluto fulvo. Conidiophora absentia. Cellulae conidiogenae* 7-10 *x* 2-3 *µm, holoblasticae, determinatae, discretae, terminales, hyalinae, leves, cylindricae vel lageniformes elongatae cum conidio singulari terminali. Conidia in superficiebus omnibus interioribus conidiomatorum formata. Conidiogenesis primum in conidioma summa, tum in conidioma ima reperta. Paraphyses usque ad* 50 *x* 1-1.5 *µm supra conidiomatis tum orientes. Conidia tetracellulae,* (16-)18-23(-27) *x* 3-4 [$\bar{x}$=21.3 *x* 3.4] *µm, dilute aureobrunnea, tenuiparietes, dorsiventralia,* 2 *cellulae mediae* (10-)12-15(-17) [$\bar{x}$=13.8] *µm, cellulae terminales obtuse rotundatae vel cellula basalis aliquando truncata cum costa minuta basali, cellulae apicalis et basalis setulam bifurcatam suprabasalem et subapicalem affixam circa in pariete medio in latere concavo conidii ferentes, utraque furca ca* 12-20 *µm longa, appendix basalis exogena.*

Holotypus: Ex foliis Ceanothus fendleri Gray, Hermosa Trail, *ca* 0.5 miles *ex initio*, La Plata Co., CO., U.S.A., A. W. Ramaley, October, 1987, BPI 72043.

Conidiomata pycnidial, epiphyllous, separate or occasionally confluent, subepidermal, emergent, flattened when young, expanding outward during development, somewhat depressed globose at maturity, unilocular, ostiolate, pale tan when young, dark brown around the developing ostiole, gradually browning during maturation from the ostiole toward the base, up to 320 µm in diam, mostly 170-220 µm; ostiole small, single, circular, papillate, central or excentric, ca 10-15 µm diam; wall composed of thin-walled textura angularis, 6-8 cells thick on top, 4-6 cells thick on the bottom. Cirri light brown. Conidiophores absent. Conidiogenous cells 7-10 x 2.5-3 µm, holoblastic, determinate, discrete, terminal, hyaline, smooth, cylindrical to elongate lageniform with a single terminal conidium. Conidia formed on all inner surfaces of the conidiomata. Conidiogenesis found first at the top, then the base of the conidioma. Paraphyses up to 50 x 1-1.5 µm then arise at the top of the conidioma. Conidia 4-celled, (16-)18-23(-27) x 3-4 [$\bar{x}$=21.3 x 3.4] µm, pale golden brown, thin-walled, dorsiventral, the 2 middle cells (10-)12-15(-17) [$\bar{x}$=13.8] µm, end cells obtusely rounded or the basal cell truncate with a minute basal ridge, the apical and basal cell bearing a subapical and suprabasal bifurcate appendage inserted about midway up the wall on the concave side of the conidium, each branch ca 12-20 µm long, basal appendage exogenous.

In culture on PDA at room temperature (ca 16 C) in the light, mycelium reaches 28 mm diam after 14 days, is light tan, ages apricot in early passages, and lacks apricot pigmentation in later passages. Colonies are often sectored into areas where all mycelium is appressed to the agar, and areas with limited growth of aerial hyphae. Conidiomata are scattered and variable. They first appear as raised, darkening areas on the mycelium. Some conidiomata are like those on the natural substrate, but often the upper wall encloses several small foci of conidial development, the walls are more uniformly brown, some cells are thick-walled, and there may be multiple ostioles. Conidiogenesis takes place as on the natural substrate. Conidia are 4-celled, but the size and shape may vary. Most conidia have the appearance and dimensions of those on the natural substrate. Some conidia are shorter and broader ($\bar{x}$=15.1 x 4.8 µm, 2 middle cells $\bar{x}$=10.8 µm), somewhat constricted at the septa, and the appendages may be simple (Fig. 1, f). In ageing cultures, there may be some generalized browning of the mycelium.

Discosiospora paraphyses (Fig. 1, a, d) have not been seen in areas where active conidiogenesis is occuring. They may be derived from conidiogenous cells formed late in conidiomatal development. This is suggested by the presence of some atypically long, slender conidiogenous cells bearing conidia in areas where conidiogenesis is nearly completed.

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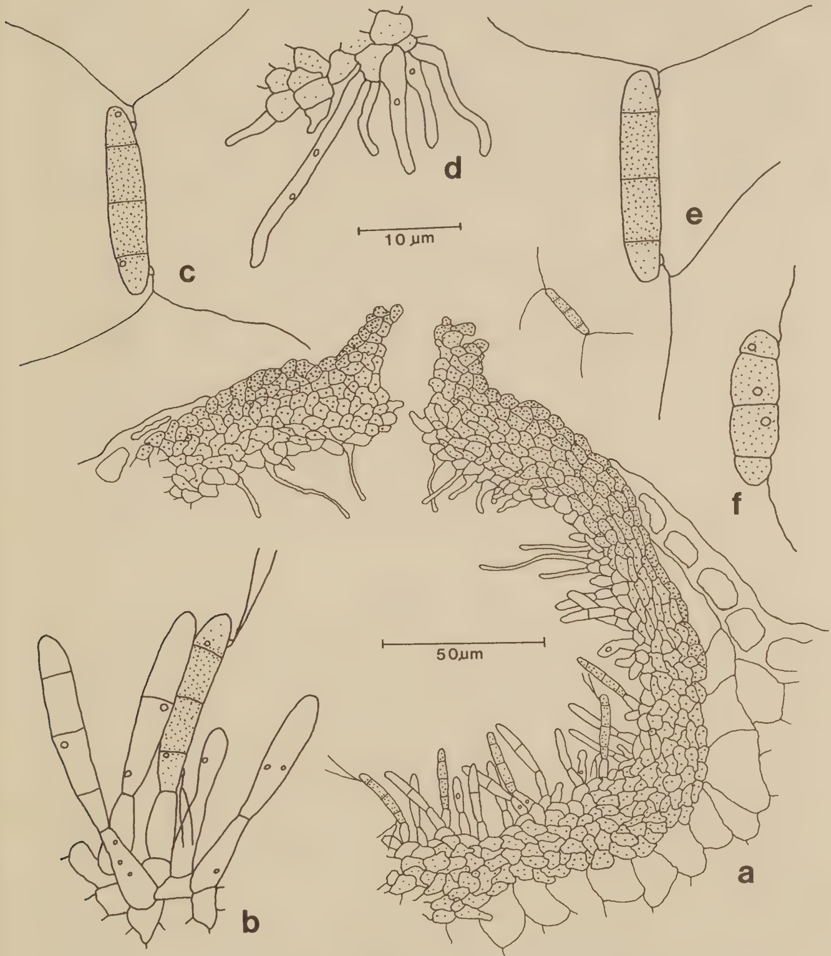

Fig. 1. *Discosiospora ceanothi.* (a) Conidioma; (b) Conidiogenesis and conidiogenous cells; (c,e) Conidia from natural substrate; (d) Paraphyses from upper wall of a conidioma; (f) Conidium from culture showing extreme of variation from normal.

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ECTOMYCORRHIZAL FUNGI ASSOCIATED WITH PINUS EDULIS IN THE PICEANCE BASIN OF COLORADO

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ABSTRACT

Ectomycorrhizae of *Pinus edulis* Engel. and sporocarps of associated fungi were collected from a pinyon-juniper woodland in northwestern Colorado. Of the eleven fungi identified, only three species, *Rhizopogon pinyonensis* Harrison and Smith, *R. ellenae* Smith and *Cenococcum geophilum* Fr. were positively determined to be ectomycorrhizal associates of *P. edulis*. Physical connections between mycorrhizae and sporocarps or sclerotia, and comparisons of cultures derived from sporocarps or sclerotia to cultures isolated from mycorrhizae provided evidence of mycorrhizal association. Thirteen types of ectomycorrhizae were described morphologically and anatomically. No endomycorrhizal associations were found.

INTRODUCTION

By recent estimates pinyon-juniper woodland occupies nearly 325,000 km^2 in the western United States (West, 1984). *Pinus edulis* Engel., pinyon pine, is an essential component of this extensive semiarid woodland ecosystem and is considered an excellent source of fuelwood and pinyon nuts as well an important habitat for wildlife (Gottfried, 1987; Lanner, 1981). Although fungal sporocarps have been collected from pinyon-juniper woodland, the mycorrhizal status of these fungi has not been positively determined (Harrison and Smith, 1968; Hesler and Smith, 1979; States, 1984). This study was undertaken to collect and describe the mycorrhizae of *Pinus edulis* and to identify putatively ectomycorrhizal fungi in a selected area of pinyon-juniper woodland.

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METHODS AND MATERIALS

Part of a pinyon-juniper woodland approximately 1.3 km by 0.6 km on a NNE to SSW oriented ridge (ca. 2070 m elevation) located in the Piceance Basin of northwestern Colorado was selected for this study. This semiarid site has a mature stand of *Pinus edulis* and *Juniperus osteosperma* (Torr.) Little (Utah juniper), with an understory of *Artemisia tridentata* Nutt. (big sagebrush) and a variety of forbs and grasses (Ward *et al*., 1974).

The site was surveyed for the presence of sporocarps of putatively mycorrhizal fungi at two to three week intervals between May and September of the years 1983 to 1986 and once in August 1987. When sporocarps were encountered, both sporocarps and an underlying soil sample containing root samples were collected as a unit. During each visit the site also was randomly sampled for ectomycorrhizal roots of pinyon pine. Root samples were taken by collecting the duff layer and the top 10 to 15 cm of mineral soil as a unit. All root and sporocarp samples were bagged and placed in a cooler until they could be returned to the laboratory for examination.

In the laboratory, the sporocarp-root-soil units were washed free of soil and examined with a dissecting microscope for mycelial attachments between the sporocarp and ectomycorrhizae. Sporocarps associated with mycorrhizae were identified, dried and retained as voucher specimens by the author. Pinyon mycorrhizae, with and without associated sporocarps, were rinsed with tap water to remove soil as well as debris. All root samples were examined with a dissecting microscope for the presence of mycorrhizae. Mycorrhizal short roots were distinguished from uncolonized short roots by the absence of root hairs, abundance of branching, and radial swelling, and by presence of a mantle and attached mycelia and rhizomorphs. Different mycorrhizal types were distinguished on the basis of morphological and anatomical features of the mantle, attached mycelia, and rhizomorphs (Zak, 1973). Anatomical descriptions were based on characters obtained by microscopic evaluation of hand sections stained with Amman's solution (Largent *et al*., 1977) and 10 μm microtomed sections stained with Conant's quadruple stain (Johansen, 1940). Each root sample was separated into different types and each type was provided a number-letter designation in which the collection number was followed by a letter indicating different mycorrhizal types within the same collection. The mycorrhizal types of each root sample were preserved in FAA (2:1:10:7, v:v:v:v, 37% formaldehyde:glacial acetic acid:95% ethanol:distilled water) and were retained as voucher specimens by the Biology Department, Colorado State University, Fort Collins, Colorado.

Standard techniques were used to isolate cultures from fresh sporocarps, sclerotia and subsamples of each mycorrhizal type within each collection (Molina and Palmer, 1982; Zak and Bryan, 1963; Zak and Marx, 1964). All isolates were maintained on Modified Melin Norkrans agar (Molina and Palmer, 1982) at room temperature. Where possible, the fungal symbionts of mycorrhizae were identified through observation of the physical attachment between mycorrhizae and sporocarps and by comparison of cultures derived from mycorrhizae to cultures derived from identified sporocarps or sclerotia.

RESULTS

Sporocarps of ten species of putatively mycorrhizal fungi (Table I) and sclerotia of *Cenococcum geophilum* Fr. were found during five surveys of the study area. There were no other sporocarps found during any other visits, despite intensive surveys of the area. Of the species found, only *Rhizopogon pachydermus* Harrison and Smith, *R. pinyonensis* Harrison and Smith, *R. ellenae* Smith, *Hysterangium brachyrhiza* States *nom. ined.*, *Geastrum fornicatum* (Huds.:Pers)Hook. *ex* Curt. and *Hygrophorus* sp. were successfully isolated from sporocarp tissue. *Cenococcum geophilum* was isolated from sclerotia.

Thirteen types (Types I-XIII) of ectomycorrhizae were described from 42 root samples of pinyon pine in the Piceance Basin. Single root collections yielded up to four different mycorrhizal types. Positive identification of the fungal symbionts was possible for only two of the 13 types of mycorrhizae. Similarities between cultures derived from sporocarp tissue and cultures from mycorrhizal roots were used to determine that both *R. pinyonensis* and *R. ellenae* were mycorrhizal symbionts of pinyon pine. Both species produced Type I mycorrhizae. *Cenococcum geophilum* was identified as a mycorrhizal symbiont by the characteristic appearance of the black mycorrhizae and sclerotia, by tracing connections between mycorrhizae and sclerotia of *C. geophilum*, and by the similarities between cultures derived from sclerotia and the mycorrhizae. *Cenococcum geophilum* formed Type II mycorrhizae. Cultures also were isolated from the root collections belonging to Types IV, V, VII and VIII but these cultures did not resemble any cultures derived from identified sporocarps.

All pinyon root samples contained roots that were ectomycorrhizal, whereas no endomycorrhizal roots were found. The ectomycorrhizae typically had a well-developed mantle, a Hartig net of branched or lobed fungal cells, no intracellular hyphae, and no root hairs. Descriptions of the mycorrhizal types follow. Those types in which the fungal symbiont was identified (Type I and II) and the types most common on the site (Type V and XI, each found in over 30% of the root collections examined) were extensively characterized. Short descriptions of the remaining types (each found in less than 15% of the root collections) were also included.

Type I
(Figure 1)

MANTLE: white or cream, some with lilac tinges, surface woolly or cottony, 7-100 µm thick; tissue in cross sectional view prosenchymatous; hyphae arranged both parallel and perpendicular to long axis of root, hyphae of inner layers in cross sectional view compactly arranged, cells with smooth walls, hyphae of outer layers more loosely arranged, cells of smaller diam and walls with plate-like incrustations, hyphae 1.5-3 (-5) µm diam, cells 2.5-25 µm long, hyphae in surface view loosely interwoven.

ROOT MORPHOLOGY: branching monopodial, bifurcate or coralloid with one to several branch points; individual root diam 357-630 µm; mycorrhizal clusters up to 4 mm long x 7 mm wide.

ANATOMY: cells of outer cortical tiers sometimes radially expanded; Hartig net between cells of outer two to four cortical tiers, one to

Table I. Sporocarps of putatively mycorrhizal fungi found in association with *Pinus edulis*.

Species	Date of Collection	Accession number[a]
Rhizopogon pachydermus Harrison and Smith	22 June 1983	382 (1), 383 (2), 388 (1)
	11 Aug. 1986	451 (1)
Rhizopogon pinyonensis Harrison and Smith	22 June 1983	389 (4)
	10 Aug. 1987	456 (1), 457 (1)
Rhizopogon ellenae Smith	27 Aug. 1984	402 (14)
	16 May 1985	412 (3)
Hysterangium brachyrhiza States *nom. ined.*	22 June 1983	384 (2), 385 (4) 386 (13), 390 (5)
	27 Aug. 1984	405 (9)
	16 May 1985	409 (1)
	10 Aug. 1987	451 (6)
Geastrum fornicatum (Huds.:Pers.)Hook. *ex* Curt.	27 Aug. 1984	397 (21)
Hygrophorus sp.	27 Aug. 1984	401 (7)
	11 Aug. 1986	408 (2)
Lactarius barrowsii Hesler and Smith	27 Aug. 1984	396 (4), 398 (1)
	11 Aug. 1986	449 (10)
Chroogomphus tomentosus (Murr.) Miller	27 Aug. 1984	399 (3), 400 (2), 404 (2)
Russula rosacea (Pers.:Secr.) Fr.	11 Aug. 1986	450 (8)
Inocybe sp.	22 June 1983	387 (22)

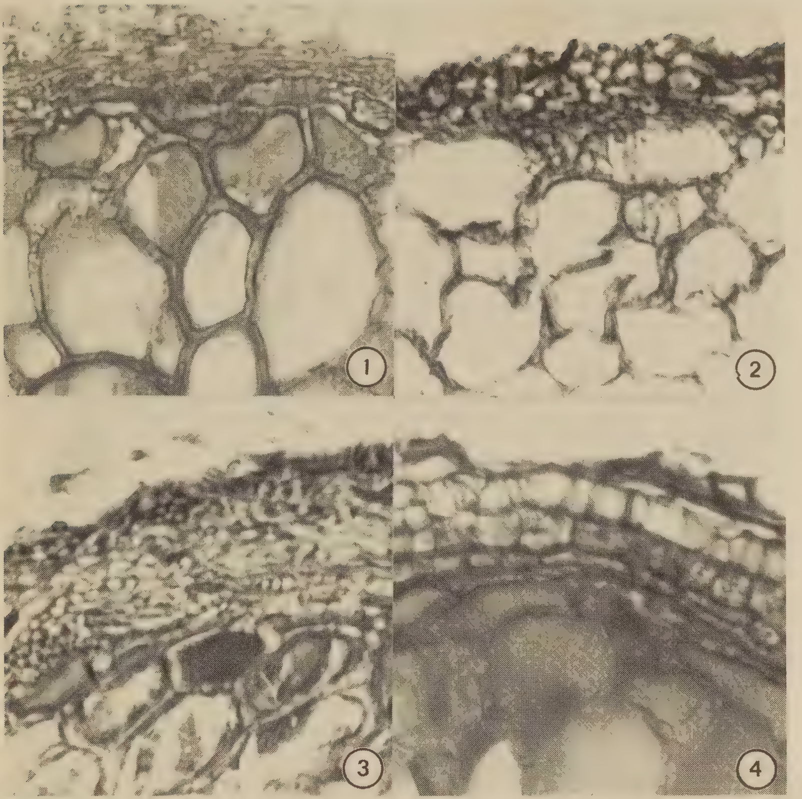
[a] Each accession number is a collection associated with a different tree on the site; numbers in parentheses are sporocarps per collection.

two hyphal cells wide, hyphae septate, 3-5 μm diam, with unevenly thickened walls.

ATTACHED MYCELIUM: hyaline, texture gossamer or cottony, densely attached to mantle; hyphae 2-6 μm diam, walls with plate-like incrustations, form straight with regular branching pattern, no clamp connections observed; crystals along outside of hyphae, no reaction to 15% KOH.

RHIZOMORPHS: white, branched, texture cottony, diam less than 0.15 mm; adhering to mantle; component hyphae septate, tightly compacted and interwoven, 2-6 μm diam, branched, with smooth, thick walls.

FUNGAL SYMBIONT: *Rhizopogon pinyonensis* or *R. ellenae*. The mycorrhizae associated with these two species could not be distinguished on the basis of morphology and anatomy. Mycelium of



Figs. 1-4. Transverse sections of Pinus edulis roots, ca. x 530. 1. Type I mycorrhiza (root sample 29B). 2. Type II mycorrhiza (root sample 34A). 3. Type V mycorrhiza (root sample 16). 4. Type XI mycorrhizae (root sample 12B).

cultures derived from sporocarps of *R. ellenae* changed from white to vinaceous red color upon application of 4% KOH while the mycelium of cultures derived from *R. pinyonenis* had no reaction. Response of mycelium derived from Type I mycorrhizae to application of KOH and morphological comparison of these cultures with those derived from sporocarps were used to associate many of the root samples with either *R. ellenae* or *R. pinyonensis*.

COLLECTIONS EXAMINED: Root samples 12C, 14B, 19B, 21B, 23B, 31A, 34C, 42A were associated with *R. pinyonenis* and 29B, 36C, 39B, and 40C were associated with *R. ellenae*. Based on morphological and anatomical criteria 30A, 33C, and 41A were included here although cultures were not obtained from these samples.

DISTINGUISHING FEATURES: Type I was distinguished from other types by a white, cottony, prosenchymatous mantle and white cottony mycelium and rhizomorphs.

Type II
(Figure 2)

MANTLE: black, surface crusty and bristly, 18-36 μm thick; tissue in cross sectional view synenchymatous; hyphae in cross sectional view 3.8-5.1 μm diam and thick, smooth, dark walls, hyphal cells 4-7 μm long; hyphae in surface view appearing as groups of oblong cells arranged in a stellate pattern, each group separated by one to several strands of hyphae.

ROOT MORPHOLOGY: branching monopodial or bifurcate with one to three branch points; individual root diam 430-475 μm; mycorrhizal clusters up to 3.5 mm long x 4.2 mm wide.

ANATOMY: cortical cells not radially expanded; Hartig net between cells of outer two to three cortical tiers, one hyphal cell wide, hyphae septate, 2-4 μm diam, with thick walls.

ATTACHED MYCELIUM: black, texture stiff, sparsely attached to mantle; hyphae 5 μm diam, walls dark, thick, sometimes warted, form straight or undulant with irregular branching pattern, no clamp connections observed.

RHIZOMORPHS: none.

FUNGAL SYMBIONT: *Cenococcum geophilum*.

COLLECTIONS EXAMINED: 17C, 34A.

DISTINGUISHING FEATURES: Type II was distinguished by a black, bristly, syenchymatous mantle with a stellate appearance from the surface, sparse, dark attached hyphae without clamps and no rhizomorphs.

Type V
(Figure 3)

MANTLE: orange or rust brown overlain with gray, color uniform, mottled or banded with orange brown and gray brown, surface cottony, 18-51 μm thick; tissue in cross sectional view prosenchymatous; hyphae of inner layers parallel to long axis of root, outer layers perpendicular to long axis of root, hyphae in cross sectional view septate, 1.5-2.5 (-5)μm diam, with thin or thick, smooth walls; hyphae in surface view parallel and tightly compacted.

ROOT MORPHOLOGY: branching bifurcate with one to three branch points; individual root diam 320-520 μm; mycorrhizal clusters up to 7 mm long x 6.3 mm wide.

ANATOMY: cortical cells not radially expanded; Hartig net between cells of outermost three to five cortical tiers, one to two hyphal cells wide, hyphae septate, 2-4 μm diam, with thick walls near the outside surface, with thin walls deeper in cortex.

ATTACHED MYCELIUM: amber or hyaline, texture gossamer, densely attached to mantle; hyphae septate, 2-4 μm diam, walls smooth, thin or thick, form straight with regular right-angled branching pattern, no clamp connections observed.

RHIZOMORPHS: amber, branched, texture smooth, diam less than 0.1 mm, attached to mantle; component hyphae septate, tightly compacted, parallel or interwoven, 2-4 μm diam, regularly branched, with smooth, thin or thick walls.

COLLECTIONS EXAMINED: 20, 23C, 25, 26A, 29A, 30D, 33B, 35A, 36D, 37A, 40A, 42B.

DISTINGUISHING FEATURES: Type V was distinguished by an orange to rust brown, cottony, prosenchymatous mantle, hyaline or amber attached hyphae without clamp connections and amber rhizomorphs.

Type XI
(Figure 4)

MANTLE: cinnamon brown darkening to reddish brown, surface smooth, 5-69 µm thick; tissue in cross sectional view synenchymatous; hyphae in cross sectional view 3.5-18 µm diam, with smooth, dark, thick walls, cells 5-18 µm long, cells regularly rectangular and compacted; hyphae in surface view irregularly circular and plicate.

ROOT MORPHOLOGY: branching monopodial or bifurcate with, one to three (to several) branch points, constrictions along mycorrhizae give beaded appearance to root; individual root diam 300-620 µm; mycorrhizal clusters up to 7.0 mm long x 6.7 mm wide.

ANATOMY: cells of outer cortical tier sometimes radially expanded; Hartig net between cells of outer three to four cortical tiers, one to two hyphal cells wide, hypahe septate, 2-3 µm diam, with unevenly thickened walls.

ATTACHED MYCELIUM: none.

RHIZOMORPHS: none.

FUNGAL SYMBIONT: unknown.

COLLECTIONS EXAMINED: 10B, 12B, 14A, 17A, 19C, 22, 24, 26B, 30C, 32B, 34B, 36A, 39A, 40B, 42C.

DISTINGUISHING FEATURES: Type XI was distinguished by a cinnamon brown, smooth, synenchymatous mantle without attached mycelia or rhizomorphs.

Type III

Mantle gray to gray brown with a smooth surface, 30-51 µm thick, of prosenchymatous tissue; root branching monopodial or bifurcate with one to three branch points; roots 200-370 µm diam; Hartig net between cells of outer three cortical tiers, one to two hyphal cells wide; attached mycelium of hyaline, hair-like hyphae 2 µm in diam with thin, smooth walls and clamp connections; no rhizomorphs (collections examined: 8, 15D, 32A, 38).

DISTINGUISHING FEATURES: Type III was distinguished by a gray to gray brown, smooth, prosenchymatous mantle, hyaline, hair-like attached hyphae with clamp connections and no rhizomorphs.

Type IV

Mantle gray brown with a velvety surface, 15-45 µm thick, of prosenchymatous tissue; root branching monopodial or bifurcate with one to three branch points; roots 400-630 µm diam; Hartig net between cells of outer two to four (to five) cortical tiers, one to four hyphal cells wide; attached mycelium of hyaline, gossamer or hair-like hyphae 1.5-3 µm diam with thin (to thick), smooth (to punctate) walls and clamp connections; rhizomorphs amber, branched with smooth surface, made of parallel, compacted hyphae (collections examined: 10A, 15B, 17B, 18A, 31B, 33A).

DISTINGUISHING FEATURES: Type IV was distinguished by a gray brown, velvety, prosenchymatous mantle with hyaline, gossamer or hair-like attached hyphae with clamp connections and amber rhizomorphs.

Type VI

Mantle cream yellow to yellow brown with a cottony to woolly surface, 51-64 µm thick, of prosenchymatous tissue; root branching bifurcate with one to two branch points; roots 410-535 µm diam; Hartig net between cells of outer three to four cortical tiers, one to two hyphal cells wide; attached mycelium of cream yellow, gossamer hyphae 1.5-2.5 (-4) µm diam with thin, smooth walls and no clamp connections; rhizomorphs cream yellow, branched, with smooth surface, made of parallel, tightly compacted hyphae (collections examined: 16, 35B).

DISTINGUISHING FEATURES: Type VI was distinguished by cream yellow to yellow brown, cottony to woolly, prosenchymatous mantle, cream yellow, gossamer attached hyphae with no clamp connections and cream yellow rhizomorphs.

Type VII

Mantle amber to rusty brown with a velvety surface, 21-36 µm thick, of prosenchymatous tissue; root branching bifurcate with one to four branch points; roots 380-485 µm diam; Hartig net between cells of outer three (to four) cortical tiers, one hyphal cell wide; no attached mycelium or rhizomorphs (collections examined: 12A, 27).

DISTINGUISHING FEATURES: Type VII was distinguished by an amber to rusty brown, velvety, prosenchymatous mantle and no attached mycelia or rhizomorphs.

Type VIII

Mantle golden brown with a velvety surface, 51-59 µm thick, of prosenchymatous tissue; root branching monopodial or bifurcate with one to three branch points; roots 420-630 µm diam; Hartig net between cells of outer three to four cortical tiers, one hyphal cell wide; attached mycelium of hyaline to yellowish, stiff hyphae 2 µm diam with thin or thick, smooth walls and no clamp connections; no rhizomorphs (collections examined: 30B, 37B).

DISTINGUISHING FEATURES: Type VIII was distinguished by a golden brown, velvety, prosenchymatous mantle, hyaline to yellowish stiff attached hyphae with no clamp connections and no rhizomorphs.

Type IX

Mantle dark brown to black with a bristly surface, 38-46 µm thick, of prosenchymatous tissue; single-celled setae coming to an acute point, sparsely attached to mantle; root branching monopodial or bifurcate with one to two branch points; roots 400-500 µm diam; Hartig net between cells of outer two to three cortical tiers, one hyphal cell wide; no attached mycelium or rhizomorphs (collection examined: 31C).

DISTINGUISHING FEATURES: Type IX was distinguished by a dark brown to black, bristly, prosenchymatous mantle with single-celled, acutely pointed setae, no attached mycelia or rhizomorphs.

Type X

Mantle yellow brown with a velvety surface, 15-36 µm thick, of synenchymatous tissue; root branching monopodial or bifurcate with one to three branch points; roots 400-525 µm diam; Hartig net between cells of outer two to three cortical tiers, one to two (to three) hyphal cells wide; no attached mycelium or rhizomorphs (collection examined: 18C).

DISTINGUISHING FEATURES: Type X was distinguished by a yellow brown, velvety, synenchymatous mantle and no attached mycelia and rhizomorphs.

Type XII

Mantle orange brown to reddish brown with a smooth surface, 10-31 µm thick, of synenchymatous tissue; root branching monopodial or bifurcate with one to two branch points; roots 230-580 µm diam; Hartig net between cells of outer three to four cortical tiers, three to four hyphal cells wide; attached mycelium of short (less than 160 µm in length), hyaline, cystidia-like hyphae, 2-8 µm diam with thin to thick, smooth walls and no clamp connections; no rhizomorphs (collections examined: 11A, 11C, 41B).

DISTINGUISHING FEATURES: Type XII was distinguished by an orange- to reddish-brown, smooth, synenchymatous mantle, sparsely attached cystidia-like mycelia and no rhizomorphs.

Type XIII

Mantle dark brown or black with a smooth surface, (7-) 18-21 µm thick, of synenchymatous tissue; root branching monopodial or bifurcate with one branch point; roots 330-460 µm diam; Hartig net between cells of outer two cortical cell tiers, one to two hyphal cells wide; attached mycelium of brown, stiff hyphae 3-4 µm diam with thick, smooth or punctate walls and clamp connections; no rhizomorphs (collection examined: 11B).

DISTINGUISHING FEATURES: Type XIII was distinguished by a dark brown to black, smooth, synenchymatous mantle, dark, stiff attached hyphae with clamp connections and no rhizomorphs.

DISCUSSION

All of the fungal species collected on the site belong to genera previously reported to be ectomycorrhizal or putatively ectomycorrhizal (Harrison and Smith, 1968; Miller, 1982; 1983; Molina and Trappe, 1982; Smith, 1971; Smith and Zeller, 1966; Trappe, 1962). *Rhizopogon pinyonensis*, *R. pachydermus*, and *Hysterangium brachyrhiza* appear to be restricted to pinyon pine stands (Harrison and Smith, 1968; States, 1984; States, Northern Arizona University, personal communication). *Lactarius barrowsii* Hesler and Smith is found with pinyon in New Mexico, but also occurs with *Pinus ponderosa* Laws. (Hesler and Smith, 1979). Long and Stouffer (1948) note *Geastrum fornicatum* in juniper stands in the southwestern United States. *R. ellenae* has not been reported from pinyon stands, but is associated with a variety of conifers in Utah, Idaho, and Oregon (Smith and Zeller, 1966). *Chroogomphus tomentosus* (Murr.) Miller, although not known to be mycorrhizal with pines, is an associate of western hemlock (Miller, 1983). *Cenococcum geophilum* is a mycorrhizal symbiont of singleleaf pinyon, *Pinus monophylla* Torr. and Frem. and is a common associate of other pines and other ectomycorrhizal plants in a wide variety of habitats (Trappe, 1962; 1964).

Pines are generally considered to be ectomycorrhizal, and *P. edulis* is not exceptional. None of the roots examined had vesicular-arbuscular mycorrhizae (VAM). Prior to this study, Reeves *et al.*

(1979) report VAM associated with *P. edulis* roots collected in the Piceance Basin, and McDougall and Jacobs (1927) find endomycorrhizae associated with *P. monophylla.* Vesicles are common in senescent or dead roots of species that do not form functional VAM (Hirrel *et al.*, 1978). However, neither Reeves *et al.* (1979) nor McDougall and Jacobs (1927) indicate whether vesicles or arbuscules are found in pinyon roots. *Pinus edulis* may form VAM only under certain conditions, or functional VAM may not occur in this taxon.

The species diversity of putatively ectomycorrhizal fungi associated with *P. edulis* is not well documented. Harrison and Smith (1968) describe three species of *Rhizopogon* and States (1984) collected five species of hypogeous fungi associated with pinyon. States (Northern Arizona University, personal communication) indicates that at least 20 putatively ectomycorrhizal fungi have been collected in association with pinyon in the Southwest. Species diversity of ectomycorrhizal fungi can affected by a number of factors. In the Piceance Basin, during periods of the year in which the temperature is suitable for sporocarp production, moisture is a limiting factor. The mean annual precipitation is 28 to 64 cm; half of this amount occurs as winter snow. Most of the remaining moisture, which falls during intense thunderstorm activity during the summer months, is lost as runoff or evaporation (Fowells, 1965; Tiedman and Terwilliger, 1978). The infrequent production of sporocarps noted during this study indicates that in order to survive fungi must be well-adapted to the limiting environmental conditions specific to the site and the opportunities for sporocarp production rarely occur.

Species diversity of ectomycorrhizal fungi is reported to increase with age and then decrease as the stand matures (Dighton and Mason, 1985; Last *et al.*, 1987). In mature stands of *Pinus bansksiana* Lamb. only 13 species of putatively ectomycorrhizal fungal are common, whereas in young stands there are 44 species (Danielson, 1984). Dighton and Mason (1985) note a decrease in fungal diversity after canopy closure in *Pinus contorta* stands. In these stands as well as a 250 year old forest of *Pseudotsuga menziesii* (Mirb.) Franco and *Larix* sp. a single mycorrhizal fungus is dominant (Dighton and Mason, 1985; Harvey *et al.*, 1976). *P. edulis* is reported to be mature at 200 years (Fowells, 1965). Based on the height and diameter of the larger trees on the study area (personal observation) and growth rate measurement of pinyon pine by Little (1987), the stand located on the study area was estimated to be approximately 300 years. The number of fungal species found on the study area is consistent with published reports on species diversity in older stands.

There is generally a greater fungal diversity in areas where there is more than one potential host species (Mosse, *et al.*, 1981). In many locations within the range of pinyon, *Pinus edulis* is mixed with or adjacent to stands of *P. ponderosa* (Fowells, 1965; Phillips, 1909). The area in which the study site is located has pinyon-juniper woodland on the ridges and upper slopes, with sagebrush-grass communities occupying the lower slopes and valleys (Tiedman and Terwilliger, 1978; Ward *et al.*, 1974). Although *Juniperus osteosperma* may be able to form ectomycorrhizae (Reinsvold and Reeves, 1986), no ectomycorrhizae were noted associated with *J. osteosperma* on the study area (personal observation). Because *J. osteosperma* predominantly forms VAM

(Reinsvold and Reeves, 1986), this species is probably not an important alternate host for ectomycorrhizal fungi. The combination of semiarid conditions, maturity of the stand and lack of potential alternate hosts contribute to limiting ectomycorrhizal fungal species diversity on the study area.

Of the 13 mycorrhizal types collected from the site, the fungal symbiont of only two of these types was identified. The fungal symbionts of some of the unidentified mycorrhizal types may not have formed sporocarps during the time the collecting visits were made. In addition, there were cases in which physical connections could not be traced between mycorrhizae and sporocarps, the mycorrhizae or sporocarps found did not yield cultures for comparison and cultures derived from some of the mycorrhizae were not similar to any derived from sporocarps.

Failure to successfully isolate cultures from some of the field material may have been due to the media selected for isolation or the condition of some of the field material. Isolations were attempted on only one medium. Modified Melin Norkrans media is recommended for culture of ectomycorrhizal fungi (Molina and Palmer, 1982), but may not have met the growth requirements of all the fungi that were placed on it. Although attempts were made to use only fresh, insect-free sporocarps for isolation, suitable material was not always available. Sporocarps of *Russula rosacea* (Pers.:Secr.) Fr.and *Chroogomphus tomentosus* were collected on only one occasion each. The tissue of the sporocarps may not have been viable, because only dried sporocarps were found in the duff layer beneath pinyon trees.

The research presented here has established that pinyons are ectomycorrhizal in natural situations and have a unique if somewhat limited fungal flora in the Piceance Basin. Land disturbance resulting from large scale mining of oil shale, coal or minerals in western Colorado would lead to large areas of vegetation displacement. In any revegetation effort consideration must be given both to the suitability of the selected plant species and the potential of mycorrhizal fungi to affect plant survival and growth (Mikola, 1973; Trappe, 1977). A descriptive study is only a first step in determining the application of ectomycorrhizal fungi in revegetation. A mycorrhizal synthesis experiment is necessary to determine if the fungi identified and isolated from the study site are capable of forming mycorrhizae with *P. edulis*. The results of synthesis experiments involving those fungi will be presented in a later paper. Further study will indicate which species of mycorrhizal fungi are best suited to insure survival and maximum growth of *Pinus edulis* on disturbed areas.

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MYCOTAXON

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A NEW SPECIES OF BENJAMINIELLA (MUCORALES: MYCOTYPHACEAE)

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The genus *Benjaminiella* von Arx was introduced by von Arx (1981) for the illegitimate (Art. 64.1) *Benjaminia* Pidoplichko & Mil'ko (1971) and contained a single species, *B. poitrasii* (R.K. Benjamin) von Arx (syn. *Cokeromyces poitrasii* R.K. Benjamin, 1960). It was characterized by a homothallic species in which the anamorph comprises a globose fertile vesicle bearing monosporous sporangiola on long flexuous pedicels, and a teleomorph with *Mucor*-like zygospores. It is known from six collections from California, USA and Baja California del Norte, Mexico, where it occurs on rodent dung (including pack rat) and lizard dung. A second species of *Benjaminiella*, *B. multispora* Benny, Samson & Srinivasan (Benny, Kirk & Samson, 1985), was described based on an isolate from humus-rich soil collected in Maharashtra, India. It differs from *B. poitrasii* mainly by the production of sporangiola containing 2-9-spores.

The genus *Benjaminiella* was referred to the newly introduced family Mycotyphaceae by Benny, Kirk & Samson (1985), along with *Mycotypha* Fenner (1932).

A third species of *Benjaminiella* has been found to occur on lizard dung on the island of Tenerife (Canary Islands). It differs from the two known species in the production of usually bisporous sporangiola.

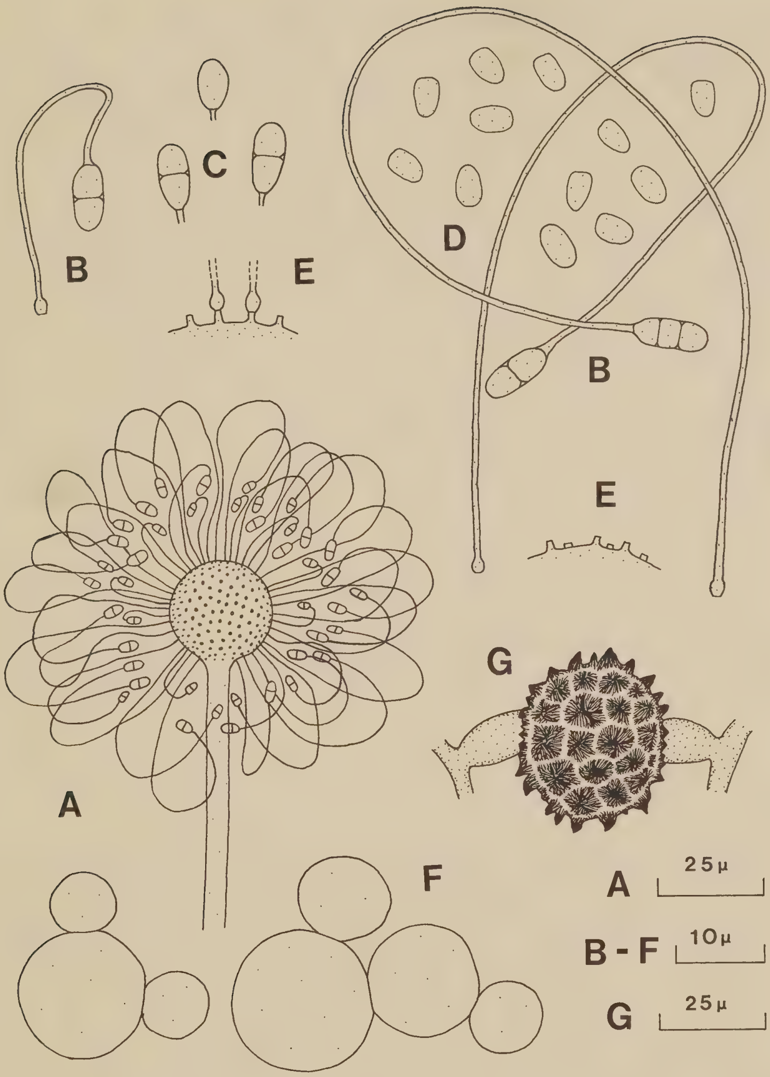
BENJAMINIELLA YOUNGII P.M. Kirk, sp.nov. (Fig 1A-F)

Etymology: For Dr T.W.K. Young, student of the Mucorales, especially their ultrastructure, mentor of the author and the person responsible for his continuing interest in this fascinating group of fungi.

Coloniae lente crescentes, exiguae, plus minusve zonatae, griseae. Sporophora simplicia, vulgo erecta, 1-3 mm alta, 5-7 (-8·5) μm lata, primo hyalina, deinde dilute brunnea, raro septata, laevia; vesiculae et sporangiola velut capitula fere globosa 60-140 μm diam apparent. Vesiculae fertiles leves, (14-) 28-42 (-55) μm diam, obpyriformes ad quasi globosae, undique sporangiola pedicellata proferentes. Pedicelli sporangiolorum longitudine variabilia, 8-130 μm longa, *c.* 0·5 μm lata, fere recta vel recurvata vel contorta, decidua, post secessionem denticulos plus minusve conicos, truncatos, 0·5-1·5 μm altos, c 0·5 μm diam, relinquentia. Sporangiola plerumque bispora, late ellipsoidea, ad sporangiosporae juncturam leviter constricta, (4·0-) 6·0-8·5 (-9·0) x (2·5-) 3·0-3·5 (-4·0) μm, levia, cito a pedicello separata; columellae minutae, indistinctae, sursum concavae, *c.* 0·5-1·0 μm diam, leves. Sporangiosporae leves, tenuitunicatae, ovoideae ad subglobosae, 3·5-6·0 x 2·5-3·5 (-4·0) μm. Hyphae submersae vulgo in cellulas hyalinas, globosas, zymoideas transeuntes usque ad 20 μm diam proferentes. Zygosporae abundantae, proximae substratum formantas; globosae vel subglobosae, (40-) 50-70 (-84) μm diam projectionibus inclusis, pariete fusco projectionibus conicis, 4·0-7·0 μm altis obtectae; suspensiores oppositi, aequales ad inaequales, leves, hyalini ad dilute brunnei. Species homothallica.

Ex stercore lacertae, Vilaflor, Tenerife, Insulae Canariae, 26 May 1988, P.M. Kirk 2085, IMI 325629, holotypus; CBS 103.89, isotypus.

Colonies on MA 3-4 cm diam in 7 days as 25°C, turf sparse, more or less zonate, Mouse Gray to Deep Mouse Gray, becoming near Light Drab in age. *Sporophores* simple at first, rarely secondarily branched, more or less erect, up to 1-3 mm high, 5·0-7·0 (-8·5) μm diam, hyaline at first, becoming light brown, sparsely septate in age; wall smooth; fertile vesicle and sporangiola forming more or less globose heads 60-140 μm diam. *Fertile vesicles* smooth, (14-) 28-42 (-55) μm diam, sometimes obpyriform but usually more or less globose, bearing pedicellate sporangiola over their entire surface.


B
C
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D
B
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A 25µ
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G 25µ

Fig. 1. *Benjaminiella youngii.* A, Sporophore. B, Pedicelate sporangiola. C, Sporangiola. D, Sporangiospores. E, Portion of fertile vesicle showing pedicel attachment. F, Yeast-like cells. G, Zygospore.

Pedicels bearing sporangiola variable in length, 8-130 µm long, *c.* 0·5 µm diam for the greater part of their length, more or less straight to recurved or strongly twisted and contorted; deciduous, with a slight basal enlargement *c.* 1·0 µm diam and 1·5-2·0 µm long immediately above the abscission zone; pedicel base after dehiscence forming a more or less conical, truncate denticle, 0·5-1·5 µm high, *c.* 0·5 µm diam at the base. *Sporangiola* bisporous or rarely uni- or trisporous, the sporangiospores in bi- and trisporous sporangiola lying parallel to the long axis of the pedicel, slightly constricted at the junction between the sporangiospores, broadly ellipsoid to obovoid, unisporous sporangiola 4·0-6·0 µm long, 2·5-3·0 µm wide, bisporous sporangiola 6·0-8·5 µm long, 3·0-3·5 (-4·0) µm wide, trisporous sporangiola 6·5-9·0 µm long, 3·0-3·5 (-4·0) µm wide, smooth, readily separating from the pedicel; columella minute, indistinct, with a concave apex, *c.* 0·5-1·0 µm diam, smooth. *Sporangiospores* smooth, thin-walled, ovoid to broadly ellipsoid, 3·5-6·0 µm long, 2·5-3·5 (-4·0) µm wide. *Substrate hyphae* at first non-septate, becoming irregularly septate in age; giving rise to hyaline, globose, yeast-like budding cells up to 20 µm diam. *Zygospores* abundant, formed near the surface of the substratum from aerial hyphae; globose to subglobose, (40-) 50-70 (-84) µm diam including the projections; wall dark brown, covered with more or less conical projections 4-7 µm high; suspensors opposed, isogamous to slightly anisogamous, smooth, hyaline to light brown. Homothallic.

DISTRIBUTION: Canary Islands, Tenerife; known only from the type locality.

NOTES: Colonies of *Benjaminiella youngii* on MA are superficially identical to those of the other two species of *Benjaminiella*, *B. poitrasii* and *B. multispora.* The anamorph formed dense colonies on the natural substratum within four days of incubation at *c.* 20°C on moist filter paper in a petri dish. After a further three days zygospores were also formed. The isolate was easily brought into culture using malt agar containing a mixture of penicillin and streptomycin. Initially the germinating sporangiospores formed colonies of yeast-like cells. However, the hyphal phase, followed by the production of sporophores and zygospores, developed within three days.

The typically bisporous, rarely uni- or trisporous, sporangiola serve to distinguish *B. youngii* from the other two species.

KEY TO SPECIES OF *BENJAMINIELLA*

1.	Sporangiola containing one sporangiospore	*B. poitrasii*
	Sporangiola usually containing more than one sporangiospore	2
2.	Sporangiola with 1-3 linearly arranged sporangiospores	*B. youngii*
	Sporangiola with 2-9 irregularly arranged sporangiospores	*B. multispora*

The author is grateful to Drs R.K. Benjamin and G.L. Benny for commenting on the novelty of the isolate and Dr D.W. Minter for correcting the Latin.

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ADDITIONS TO THE KNOWLEDGE OF PHAEOCOLLYBIA (AGARICALES, CORTINARIACEAE) FROM MEXICO, WITH DESCRIPTION OF NEW SPECIES*

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SUMMARY

Three new species of Phaeocollybia from Mexico are described: P. latispora Guzmán, Bandala-Muñoz & Montoya-Bello, P. martinicensis Guzmán, Montoya-Bello & Bandala-Muñoz and P. singerii Guzmán, Bandala-Muñoz & Montoya-Bello. Also three new records are discussed: P. arduennensis Bon, P. hilaris (Fr.) Heim and P. oligoporpa Sing., the first two species are known only from Europe and the last from Costa Rica. Moreover, P. californica Smith, P. christinae (Fr.) Heim and P. kauffmanii (Smith) Sing. previously recorded from Mexico are reported from new localities. A synoptical key to the 15 known species of this genus in Mexico is provided.

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INTRODUCTION

This paper is a continuation of the study of Phaeocollybia in Mexico recently started by the authors (Guzmán et al., 1986; 1987). Seven species in the Sections Phaeocollybia and Versicolores from coniferous forests were previously discussed. Three new species are described and 6 new records are presented here, from coniferous and mesophytic forests, which extends the genus into the subtropical regions of Mexico. In addition to the reviewed bibliography discussed by the authors (Guzmán et al., 1987), Pérez-Silva et al. (1986) recorded P. fallax Smith and those species reported by Guzmán et al. (1986; 1987). Recently, Díaz-Barriga et al. (1988) reported P. kauffmanii (Smith) Sing. from the State of Michoacan. Then, there are 15 species of Phaeocollybia known in Mexico as discussed below.

The present paper is based on the study of fresh specimens collected by the authors, and on exsiccata of the Herbarium of Facultad de Ciencias of the University of Mexico (FCME) and of the Herbarium of Escuela Nacional de Ciencias Biológicas of the Instituto Politécnico Nacional (ENCB). The specimens collected by the authors were deposited in FCME, ENCB and in Instituto Nacional de Investigaciones sobre Recursos Bióticos (XAL) (now named Instituto de Ecología).

DESCRIPTION OF NEW SPECIES

Phaeocollybia latispora Guzmán, Bandala-Muñoz & Montoya-Bello, sp. nov.

Figs. 1-7

Pileo 18-35 (-40) mm lato, conico vel conico-umbonato, apex subacutus, siccus vel oleosus, rufobrunneus vel brunneus aurantiacus. Lamellis pallide aurantius, marginis pallidus. Stipe (50-) 80-110 (-200) X 2-8 (-10) mm, cum pseudorrhiza, fusoideo-radicato brunneus aurantiacus cum vinaceous tinctum. Sporis (8.8-) 9.6-11.2 (-12) X 5.6-7.2 µm, crasse verrucose, limoniformibus vel sublimoniformibus. Cheilocystidia (16-) 21.6-32 (-40) X

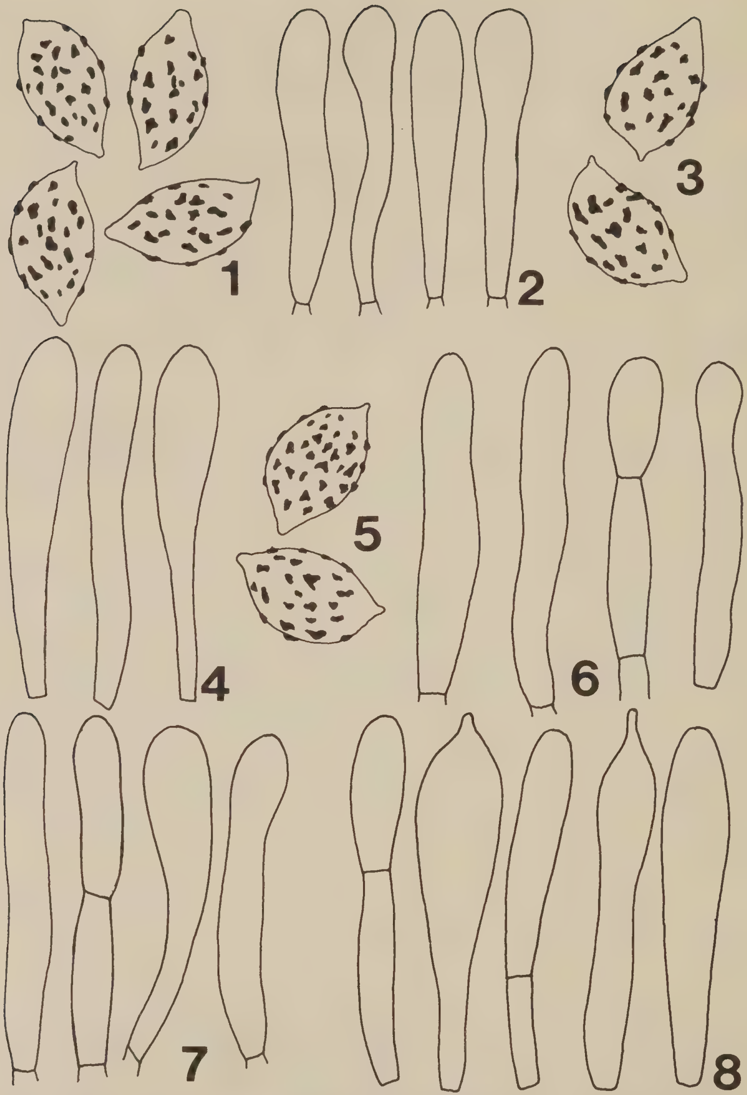
(3.2-) 4-8 (-8.8) µm, copiosus, clavatis vel cylindraceus clavatis. Epicute gelatinous. Fibulis infrequens. Ad terram in Pinus et Abies sylva. Prope El Chico sylva, ad Hidalgo (MEXICO) Typus: Chacón 8 (XAL).

Pileus 18-35 (-40) mm broad, conic or subconic to convex umbonate, subacute in the apex, dry to lubricous, glabrous, reddish-brown to orange-brown. Lamellae subadnexed to nearly free, close, pale orange, edges lighter. Stipe (50-) 80-110 (-200) X 2-8 (-10) mm, fusoid, gradually attenuating into a short pseudorrhiza buried into the ground, fibrous, orange brown with vinaceous tinges, dark vinaceous towards the basal portion.

Spores (8.8-) 9.6-11.2 (-12) X 5.6-7.2 µm, limoniform or sublimoniform, coarsely verrucose, orange-brown to yellowish brown in KOH, inamyloid, thin walled. Basidia 20-40 X 8-9 (-12) µm, tetraspored, clavate, hyaline. Pleurocystidia absent. Cheilocystidia (16-) 21.6-32 (-40) X (3.2-) 4-8 (-8.8) µm, abundant, clavate or cylindric-clavate, hyaline, thin walled, sometimes covered with a gelatinized layer. Epicutis consisting of gelatinized, thin walled, slightly incrusted hyphae 2.4-8 µm wide, hyaline to yellowish in KOH. Hypodermium with thin walled incrusted, yellowish or brown hyphae (4-) 7.2-14.4 µm thick. Context consisting of thin walled, smooth, hyaline hyphae 4.8-20 (-24) µm thick. Hymenophoral trama regular, hyphae of 4-8 (-12) µm wide, hyaline, thin walled, smooth. Clamp connections rare or absent.

HABITAT. Gregarious on humus in coniferous (Pinus and Abies) forests.

MATERIAL STUDIED. STATE OF HIDALGO, road Mineral del Monte to El Chico, National Park El Chico, Chacón 8 (Type, XAL). STATE OF MEXICO, Popocatepetl Volcano, road Amecameca to Tlamacas, Guzmán 855 (ENCB). National Park Nevado de Toluca, road to Sultepec, km. 21, El Capulín, Valenzuela 2603 (ENCB). STATE OF MORELOS, road Huitzilac to Lagunas de Zempoala, Guzmán 23993 (ENCB). STATE OF VERACRUZ, Eastern Cofre de Perote mountain, Xico Council, El Revolcadero, Villa-



Figs. 1-8.- 1-7: *Phaeocollybia latispora*, 1: spores; 2: cheilocystidia; 3: spores; 4: cheilocystidia; 5: spores; 6-7: cheilocystidia(1-2: Chacón 8, Type; 3 & 7: Valenzuela 2603; 4: Villarreal 1303; 5-6: Guzmán 855).8: *Phaeocollybia martinicensis*, cheilocystidia (Guzmán 16380, Type).

rreal 1303 (XAL).

OBSERVATIONS. This species is mainly recognized by its bigger and coarsely verrucose spores, the gelatinized cuticle and the scarce clamp connections. It is close to P. similis (Bres.) Sing. (no P. similis sensu Smith), but that species is only known from deciduous forests of China and has not gelatinized cuticle and cheilocystidia 17-21.5 X 6-11 µm, according to Singer (1987). However, Horak (1976-1977) described a gelatinized cuticle and cheilocystidia of 25-40 X 3-7 µm based in the same type collection studied by Singer. Horak reported hyphae without clamp connections and Singer with clamp connections.

The specimens Guzmán 855 and Valenzuela 2603 mentioned above, agree with the type but not clamps were observed and their cuticle is poorly gelatinized. This fact relates these specimens to P. christinae (Fr.) Heim s.s., P. attenuata (Smith) Sing. and P. piceae Smith & Trappe (this later not known from Mexico). However, the first one has spores 4-5 µm broad, the second one with spores 8-9 (-10) X (4-) 5-6 µm and the last one with cespitose habit and slightly smaller spores 4.5-6 µm or 5-6 (-6.5) µm broad (Smith and Trappe, 1972; Horak, 1976-1977).

The presence of clamps and the spores size place P. latispora in Section Subattenuata Sing. but it is also close to Section Phaeocollybia if we consider the clamps as rare or absent. It is probably that P. latispora together with P. similis belong to another new section.

Phaeocollybia martinicensis Guzmán, Montoya-Bello & Bandala-Muñoz, sp. nov.

Figs. 8-10 & 36-37

Pileo approximatus 20 mm lato, plano-convexus, apex acutus, viscidus, ochraceus vel fulvus. Lamellis fulvus pallidus. Sporis 7.2-8 (-8.8) X 4-4.8 µm, minute verrucose, amygdalum forma vel subfusoideus. Cheilocystidia 24-32 X 4-6.4 µm, copiosus, clavatis mucronatus vel subcylindraceus. Epicutis gelatinous. Hyphis difibulatis. Ad terram in subtropicus sylva. Prope La Martinica, ad Banderilla (Veracruz, MEXICO). Typus: Guzmán 16380 (ENCB).

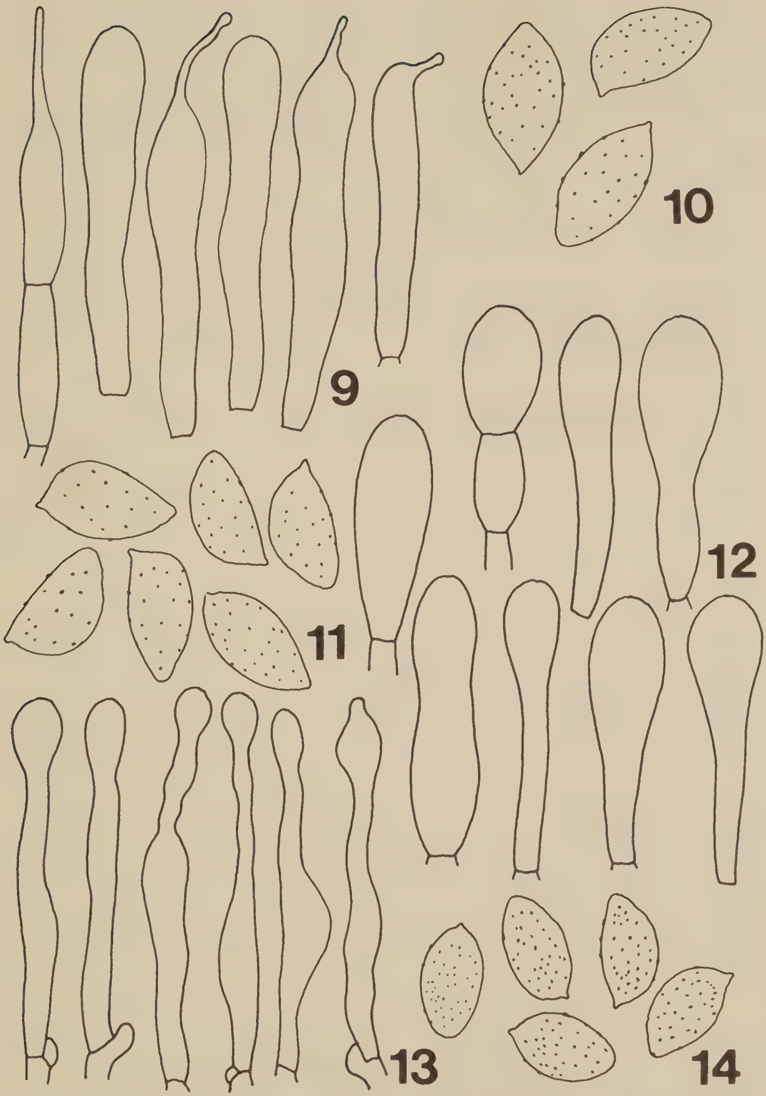
Pileus approximately 20 mm broad, plano-convex with an acute apex, margin slightly inrolled, glabrous, viscid, ochraceous to yellowish-brown. Lamellae subadnexed to nearly free, close, light yellowish-brown with whitish edges. The exsiccati studied only has a small basal portion of the stipe.

Spores 7.2-8 (-8.8) X 4-4.8 µm, almond-shaped, slightly subfusoid in frontal view, minutely verrucose to nearly verrucose-punctate, light orange-brown to yellowish-brown in KOH, inamyloid, thin walled. Basidia (25-) 32-45 (-50) X (5-) 6-8 µm, tetraspored, clavate, hyaline. Pleurocystidia none. Cheilocystidia 24-32 X 4-6.4 µm, abundant, clavate-mucronate, subcylindric or subcylindric-mucronate, hyaline, thin walled, sometimes slightly strangulate, flexuous or with a medial septum or short-cylindric with a thin, short or long apical portion 2-7 (-10) X 1-2 µm. Pileus cuticle with gelatinized hyphae, hyaline, 2.4-3.2 µm wide, thin walled, smooth; subcutis with yellowish-orange, thin walled, incrusted hyphae 2.4-3.2 (-4) µm wide. Pileus trama consisting of thin walled, yellowish hyphae 4-5.6 µm thick. Hymenophoral trama subregular, hyphae 4.2-5.6 µm wide, yellowish, thin walled. Clamp connections absent.

HABITAT. Solitary on humus in a mesophytic forest.

MATERIAL STUDIED. STATE OF VERACRUZ, SW of Banderilla, Cerro de La Martinica, Guzmán 16380 (Type, ENCB).

OBSERVATIONS. The form of the cheilocystidia and size of the spores separate this species from P. californica Smith and P. cidaris (Fr.) Heim no s. Ricken. The first one has spores of 9-10 (-11) x 4-5 µm (Guzmán et al., 1987) and the later has cylindric-capitate cheilocystidia



Figs. 9-14.- 9-10: *Phaeocollybia martinicensis*, 9: cheilocystidia ; 10 spores (Guzmán 16380, Type). 11-12: *Phaeocollybia singerii*, 11: spores; 12: cheilocystidia (Bandala-Muñoz 1008,Type). 13-14: *Phaeocollybia arduennensis*, 13: cheilocystidia; 14: spores(Villarreal 2622).

(Horak, 1976-1977). Moreover both species are associated to coniferous forests. In spite of the poor condition of the exsiccati studied, it has been described here as new species, because of its conclusive distinguish features. The absence of clamps, the spore size and the cheilocystidia form suggest affinities with the Section Versicolores Sing.

The name of the species refers to the type locality, Cerro La Martinica, where some endemic species had been founded, such as Psilocybe banderillensis Guzmán and P. xalapensis Guzmán & López (Guzmán, 1983).

Phaeocollybia singerii Guzmán, Bandala-Muñoz & Montoya-Bello, sp.nov.

Figs. 11-12 & 33-35

Pileo approximatus 50 mm lato, crasso campanulatus, cum minutus conicus umbo, oleosus, fulvus pallidus. Lamellis griseolus badius, marginis pallidus. Stipe approximatus 158 X 10 mm, cum longus pseudorrhiza, brunneus aurantiacus, rufobrunneus vel nigrans ad basis. Sporis (7.2-) 8-8.8 X 4-4.8 (-5.6) µm, amygdalum forma vel subfusoideus, minute verrucose vel verrucose punctatus. Cheilocystidia 17.6-25.6 X 4-6.4 (-7.2) µm, copiosus, clavatis, clavatis subcapitatis vel clavatis subglubosis, interdum sublageniformis vel subutriformis, interdum uniseptatus. Epicutis gelatinous. Hyphis defibulatis. Circa Coatepec Viejo, ad Coatepec (Veracruz, MEXICO). Typus: Bandala-Muñoz 1008 (XAL).

Pileus approximately 50 mm diam., broadly campanulate with a small conic umbo, margin slightly inrolled, glabrous, lubricous, light yellowish-brown. Lamellae subadnexed to nearly free, crowded, grayish brown with light edges. Stipe approximately 158 X 10 mm, tapering into a long pseudorrhiza which is buried into the ground almost half its lenght, glabrous, fibrous, elastic, orange-brown, vinaceous-brown to nearly blackish towards the base. Context whitish with superficial brown or gold brown tinges; odour slightly farinaceous.

Spores (7.2-) 8-8.8 X 4-4.8 (-5.6) µm, almond-shaped, subfusoid in frontal view, minutely verrucose or verrucose punctate, yellowish in KOH, inamyloid, thin walled. Basidia (20-)24-28.8 X 6.4-8 µm, tetraspored, clavate, hyaline. Pleurocystidia none. Cheilocystidia 17.6-25.6 X 4-6.4 (-7.2) µm, abundant, clavate, clavate-subcapitate, clavate-subglobose, sometimes sublageniform, subutriform or with a medial septum, hyaline, thin walled. Pileus cuticle with gelatinized hyphae, hyaline, 2.4-5.6 µm thick, thin walled, smooth. Subcutis poorly diferentiated, consisting of thin walled, 2.4-3.2 (-4) µm wide hyphae, yellowish or orange-brown in KOH. Pileus trama with hyphae 4-5.6 µm broad, yellowish, thin walled. Hymenophoral trama regular, hyphae (4-) 9.6-19.2 µm broad, hyaline to yellowish in KOH, thin walled. Clamp connections absent.

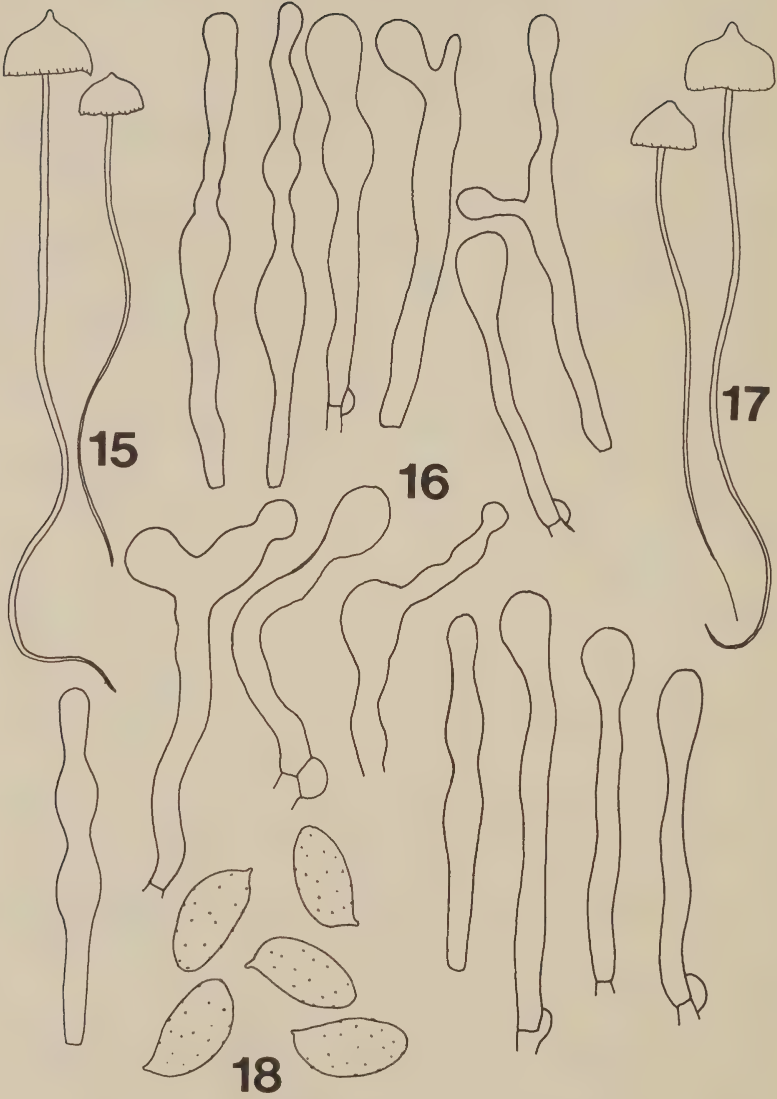
HABITAT. Solitary, on humus in a mesophytic forest.

MATERIAL STUDIED. STATE OF VERACRUZ, Coatepec Council, 3 km northwest from Coatepec, road to Coatepec Viejo, Bandala-Muñoz 1008 (Type, XAL; Isotype, IBUG).

OBSERVATIONS. This species is distinguished by the pileus color, the gelatinized cuticle, spores size and the cheilocystidia form and size. It is close to P. procera Horak from Nothofagus forests of Papua New Guinea, but differs for the cheilocystidia distinctly cylindric, 20-30 X 5-8 µm and the spores "with low warts, ornamentation often cloudy-marbled" (Horak, 1976-1977).

P. singerii is stated in the Section Phaeocollybia because of the cheilocystidia form, clampless hyphae and the spore size, following Singer's concept (1987).

The name of the species is in honor to Dr. Rolf Singer, because of his great contribution to



Figs. 15-18.- 15-17: *Phaeocollybia arduennensis*, 15: basidiocarps; 16: cheilocystidia; 17: basidiocarps (15-16: Villarreal 2683; 17: Villarreal 2244). 18: *Phaeocollybia hilaris*, spores (Sampieri 540).

the knowledge of the Mexican mycology since 1949.

NEW RECORDS OF PHAEOCOLLYBIA IN MEXICO

Phaeocollybia arduennensis Bon, Doc. Mycol. 9: 42, 1979.

Figs. 13-17

Pileus 5-18 mm broad, conic, slightly acute in the apex to subconvex-umbonate, hygrophanous, glabrous, lubricous to dry, sometimes with an undulated margin, orange brown. Lamellae adnexed, close, light orange-brown to pallid yellowish-brown, edges whitish. Stipe 70-130 X 1-2 (-3) mm, fusoid, gradually attenuating, into a long pseudorrhiza, silky, subcartilaginous, concolorous with the pileus surface or yellowish-orange above and reddish brown or blackish in the base. Context yellowish with slightly raphanoid odor.

Spores 6.4-8 X 4-4.8 (-5.6) µm, ovoid to subellipsoid, minutely verrucose, pale orange-brown to yellowish in KOH, inamyloid, thin walled. Basidia 25.6-37.6 X 6.4-8 (-8.8) µm, clavate hyaline, tetraspored, rarely bi or trispored, frequently clamped. Pleurocystidia absent. Cheilocystidia (21.6-) 25.6-52 (-74.4) X 2.4-4.8 µm, numerous, cylindric-capitate, moniliform or submoniliform, sublageniform capitate with a thin and long neck, sometimes inflated basaly or medialy, others with a small lateral prolongation, flexuous, (3.2-) 4-8 µm thick in the apical portion (capitulum), frequently clamped, hyaline, thin walled. Epicutis poorly diferentiated, consisting of hyaline, thin walled, nongelatinized hyphae 1.6-4.8 µm thick, sometimes incrusted. Subcutis not gelatinized, orange brown or yellowish pigmented with distinct incrustations, consisting of hyphae 7.2-12 (-18.4) µm broad, thin walled, forming a layer which is well differentiated from the epicutis. Pileus trama with hyphae 4-14.4 (-23.4) µm wide, hyaline to yellowish in KOH, thin walled, rarely incrustated. Gill trama subregular, hyphae 4-16 µm thick, hyaline or yellowish in group, smooth and thin walled. Clamp connections common.

HABITAT. Subgregarious among mosses, on humus in Pinus-Abies forests.

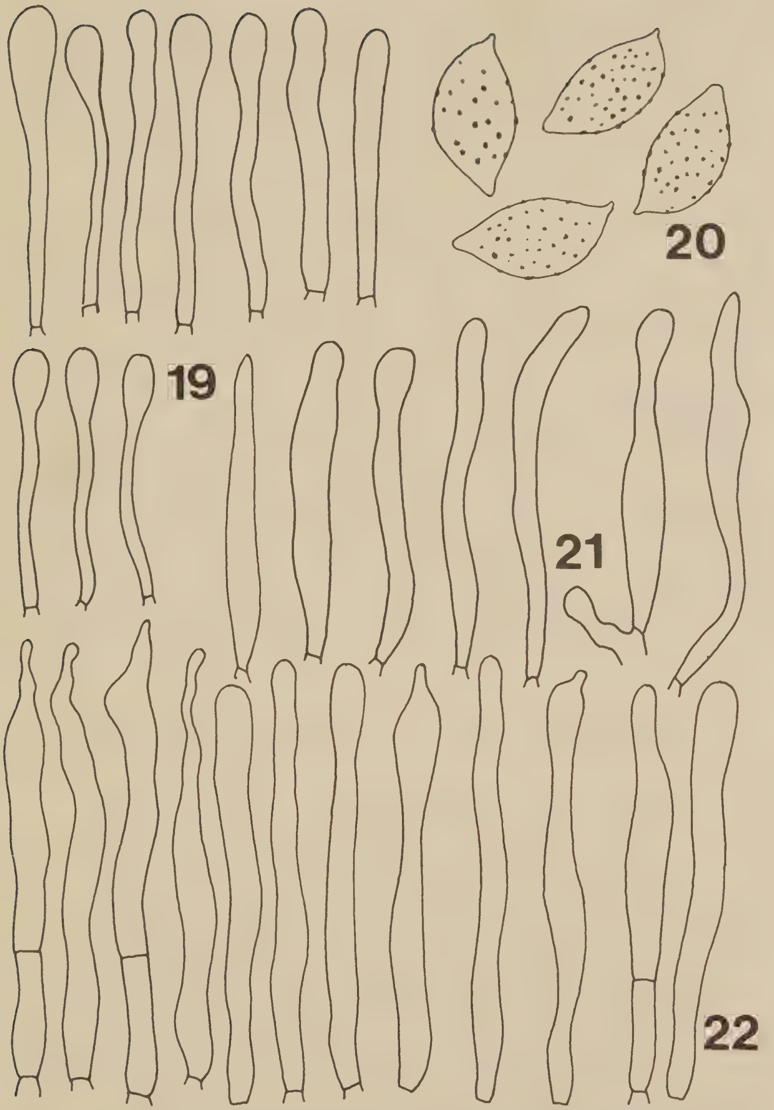
MATERIAL STUDIED. STATE OF VERACRUZ, Eastern Cofre de Perote mountain, Xico Council, 1 km Northern Ingenio El Rosario, Los Gallos, Villarreal 2244, 2622, 2683 (all in XAL).

OBSERVATIONS. The polymorphous and conspicuous cheilocystidia seem the most typical features of this species. The specimens studied agree with Bon (1979) and Singer (1987) but these authors considered spores 5-6 X 3-4.5 µm or 5.5-7 X 4-4.7 µm and cheilocystidia 25-35 µm long or 26-43 µm long, respectively. It is posible to mistaken this species with the related P. subarduennensis Sing., but this differs in growing under Quercus and Chusquea forests from Costa Rica (Singer, 1987). P. radicata (Murr.) Sing. is another close species, but it has more robust basidiocarp (pileus up to 40 or 60 mm diameter) and cheilocystidia 18-30 µm long (Murrill, 1917; Smith, 1957; Horak, 1976-1977; Singer, 1987). P. arduennensis was known only from Picea and Picea-Pinus forests in Europe (Bon, 1979; Singer, 1987). This is the first record in Mexico. The small spores and presence of clamp connections placed P. arduennensis in Section Radicatae following the concept of Singer (1987).

Phaeocollybia hilaris (Fr.) Heim, Le genre
Inocybe, p. 71, 1931.
[non P. hilaris (Fr.) Heim s. auct.]
= P. cidaris (Fr.) Heim s. Bresinsky,
1958.

Figs. 18-19

Pileus approximately 27 mm broad, convex-umbonate with a conic umbo, margin inrolled at first then becoming plane, viscid, smooth, with slightly marked short marginal striations, brown to orange-brown with some dark zones when moist,



Figs. 19-22.- 19: *Phaeocollybia hilaris*, cheilocystidia (Sampieri 540). 20-22: *Phaeocollybia oligoporpa*, 20: spores; 21-22: cheilocystidia (20-21: Guzmán 24553; 22: Bandala-Muñoz 1009).

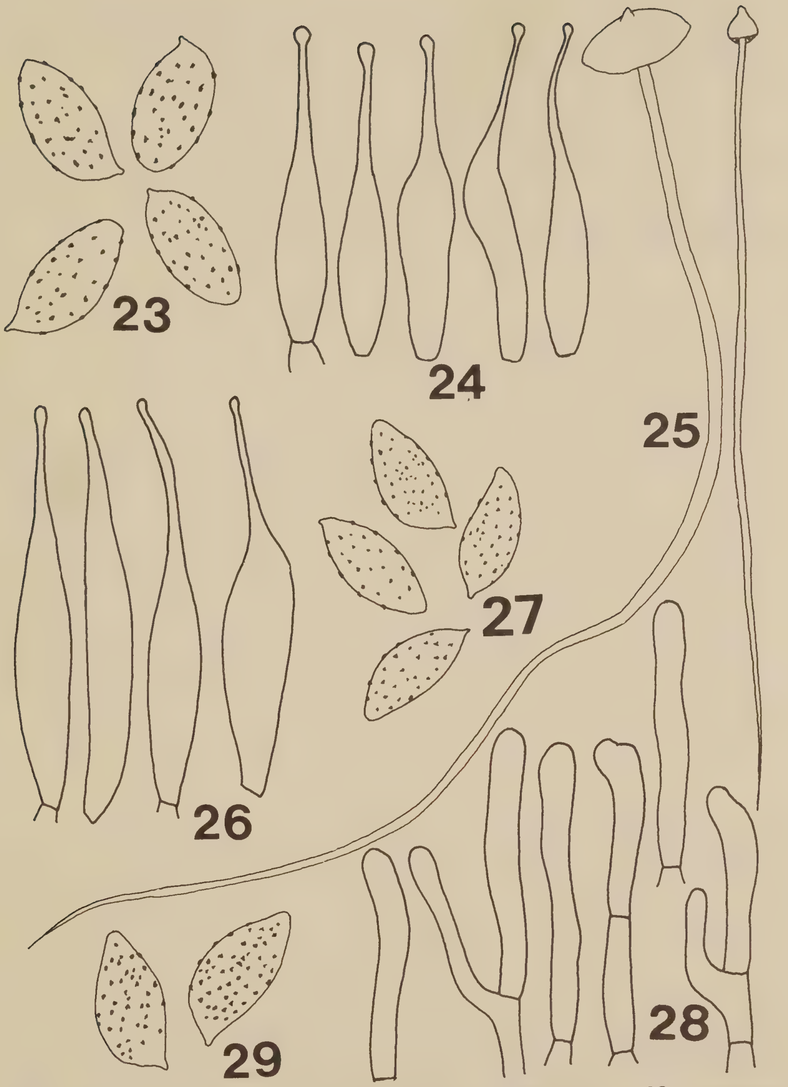
ochraceous and dark brown on the center or reddish-brown when dried. Lamellae subfree, close, yellow-brown to ferruginous brown, with whitish edges. Stipe approximately 65 X 2-3 mm, attenuated towards the base forming a short pseudorrhiza, concolorous with the pileus surface or reddish-brown, dark in the base, smooth, fibrous.

Spores 4.8-6.4 X 3.2-4 (-4.8) µm, ovoid to subellipsoid, verruculose-punctate to nearly smooth, thin walled, yellowish in KOH, inamyloid. Basidia 20-28 X 5.6-6.4 µm, cylindric-clavate, tetraspored, rarely tri or bispored, hyaline. Pleurocystidia absent. Cheilocystidia 21.6-37.6 (-44) X 1.6-3.2 µm, abundant, cylindric-capitate or filamentous-capitate, 4-5.6 µm broad in the apical region, hyaline, thin walled. Epicutis an ixocutis of hyaline, filamentous, thin walled hyphae, 1.6-3.2 (-4) µm thick, incrusted. Hypodermium consisting of thin walled, sometimes rusty incrusted hyphae, 5.6-9.6 µm broad, yellowish-brown in KOH. Context with hyaline to yellowish hyphae 5.6-20 µm thick, smooth, thin walled. Hymenophoral trama subregular, with hyaline, smooth, thin walled hyphae 4-16 µm thick. Clamp connections absent.

HABITAT. Solitary on humus, in Pinus forest.

MATERIAL STUDIED. STATE OF MEXICO, near Tlamacas, Popocatepetl Volcano, Sampieri 540 (XAL).

OBSERVATIONS. Determination of this species is based on the criteria of Horak (1976-1977) and Jacobson and Stridvall (1982-1983). The studied specimen agrees well in the clamp connections absence, spores size and in the cheilocystidia. P. hilaris s. Ricken (1915) has spores 8-9 X 4-5 µm and filamentous cheilocystidia and is considered by Kühner and Romagnesi (1957), Moser (1978), Laber (1982) and Singer (1986) as synonym of P. christinae (Fr.) Heim s. Heim 1931 (non s. Heim 1930). P. cidaris (Fr.) Heim s. Bresinsky 1958 is synonym of P. hilaris according



Figs. 23-29.- 23-26: Phaeocollybia californica, 23: spores; 24: cheilocystidia; 25: basidiocarps; 26: cheilocystidia (23-25: Peralta, Aug. 13, 1984; 26: Guzmán 5959). 27-28: Phaeocollybia christinae, 27: spores; 28: cheilocystidia (Bandala-Muñoz 298). 29: Phaeocollybia kauffmanii, spores (Montoya-Bello 1100).

to Horak (1976-1977), Jacobson and Stridvall (1982-1983) and Singer (1987), but Laber (1982) considered it as synonym of P. arduennensis Bon which has clamps (Bon, 1979; Singer, 1987).

P. hilaris was known only from coniferous forests of Europe. This is the first record of the species in Mexico. Because of its small spores and clampless hyphae it belongs to the Section Microsporae (Singer, 1986).

Phaeocollybia oligoporpa Sing., Myc. Helvetica 2: 250, 1987.

Figs. 20-22

Pileus 20-30 mm broad, conic, slightly acute umbonate to subconvex-umbonate with the apical portion obtuse, smooth, viscid to slimy, orange brown to yellowish brown or ochraceous, blackish in some parts when dried. Lamellae adnexed to subadnexed, fuscous brown or ferruginous with clear edges, close. Stipe 100-180 X 5-10 mm, fusoid, tapered downwards, forming a long pseudorrhiza which is buried into the ground, orange brown, vinaceous brown towards the base, smooth, polished, subcartilaginous. Context yellowish with reddish brown tones.

Spores (9-) 10-11.2 X 5.6-7.2 µm, sublimoniform, ellipsoid in frontal view, minutely verrucose, with a distinct mucro, pale orange-brown in KOH, inamyloid, thin walled. Basidia 28-40 X 7.2-10.4 µm, tetraspored, rarely trispored, clavate, hyaline, most clamped in the base. Pleurocystidia absent. Cheilocystidia (21.6-) 22-48 (-57.6) X 3.2-5.6 µm, abundant, mostly cylindric-flexuos, variable in form, being filamentous, fusoid, clavate-mucronate, subventricose-capitate, sometimes with the basal or medial portion inflated, hyaline, thin walled. Epicutis gelatinized, consisting of thin walled, hyaline, sometimes incrusted hyphae 1.6-6 µm thick. Subcutis of yellowish brown or pale orange to yellowish hyphae 4-8 µm wide, thin walled, incrusted. Context consisting of hyaline, thin walled, smooth 4-10.4 (-12) µm wide hyphae. Hymenophoral trama subregular, thin walled, 4-8 µm broad hyphae, hyaline to yellowish in KOH. Clamp connections present but rare.

HABITAT. Subgregarious on humus in mesophytic forests and coniferous forests both with Quercus.

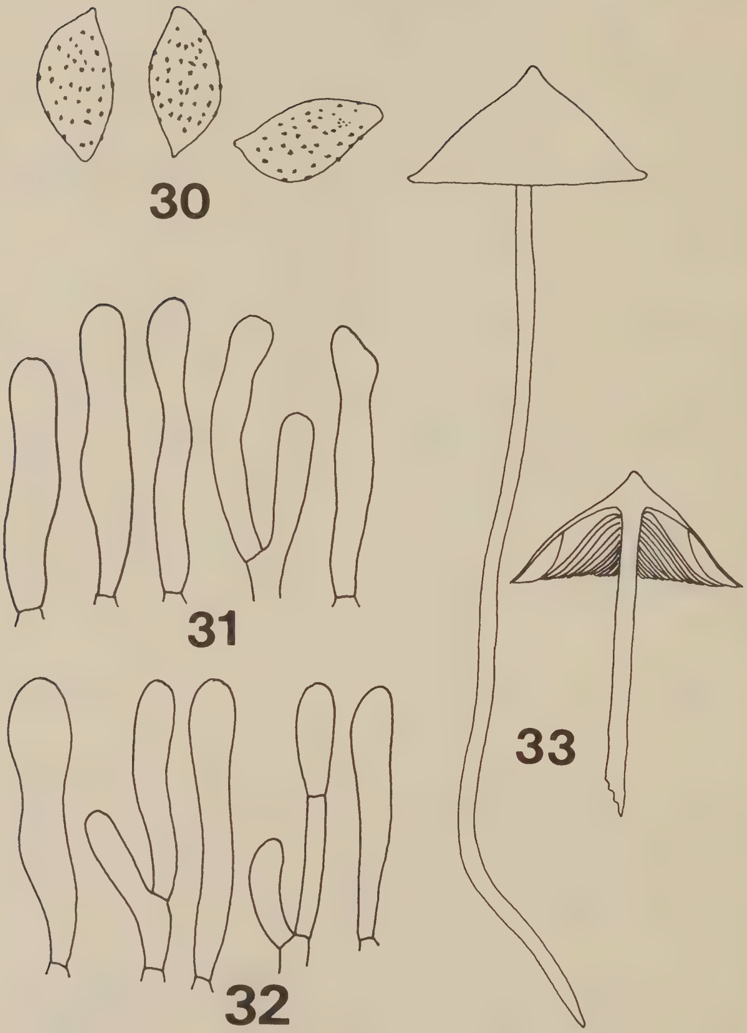
MATERIAL STUDIED. STATE OF MORELOS, Lagunas de Zempoala, Guzmán 24553 (XAL). STATE OF VERACRUZ, Huatusco Council, road Totutla-Huatusco, near Huatusco, Bandala-Muñoz 1009 (XAL).

OBSERVATIONS. This species was known only from Quercus forests in Costa Rica (Singer, 1987), and is distinguished by the variable cheilocystidia. P. latispora Guzmán, Bandala-Muñoz & Montoya-Bello and P. similis (Bres.) Sing. (see above) are close to P. oligoporpa, but they have more acute and coarsely verrucose spores and the cheilocystidia are claviform and cylindric. This is the first record of P. oligoporpa from Mexico. Singer (1986; 1987) considered P. oligoporpa along with P. similis, in the Section Subattenuata, because of the presence of clamps and large spores.

NEW LOCALITIES OF SPECIES PREVIOUSLY KNOWN FROM MEXICO

P. californica Smith, P. christinae (Fr.) Heim and P. kauffmanii (Smith) Sing., were reported from different localities in Mexico (Guzmán et al., 1987). These species have been found now in new localities in the States of Guerrero, Mexico and Veracruz, as follows:

P. californica: GUERRERO, Chilpancingo Council, Omiltemi region, Cañada de Agua fria, Pinus-Quercus forest, Peralta, Aug. 13, 1984 (FCME). STATE OF MEXICO, Popocatepetl Volcano, road Amecameca to Tlamacas, Barranca de Ameyalco, Abies religiosa forest, Guzmán 5583 ; 5959 (ENCB) (Figs. 23-26).



Figs. 30-33.- 30-32: Phaeocollybia kauffmanii, 30: spores; 31-32: cheilocystidia (30-31: Montoya-Bello 1100; 32: Montoya-Bello 1102). 33: Pheocollybia singerii, basidiocarps (Bandala-Muñoz 1008, Type).

P. christinae: VERACRUZ, Eastern Cofre de Perote mountain, Xico Council, road to Presa Alto Pixquiac, Pinus forest, Bandala-Muñoz 298 (XAL) (Fig. 27-28).

P. kauffmanii: VERACRUZ, road Xalapa to Perote, Villa Aldama Council, near Las Minas, Pinus forest, Montoya-Bello 1100 (XAL)(Figs. 29-32).

DISCUSSION

It is interesting to note that there are 15 species of Phaeocollybia in Mexico, which represent almost the 50% of the known species in the genus. Horak (1976-1977) described 34 species and Singer (1986) considered 31 species. Of the known Mexican species, P. mexicana Corner & Horak, P. neosimilis Sing., and the three new species here described seems to be endemics, but not so common, except P. latispora that seems common in Pinus and Abies forests. P. mexicana is known only from Desierto de Los Leones, D. F. (type locality, Horak, 1976-1977), and from Cofre de Perote mountain in Veracruz, and P. neosimilis from the Popocatepetl Volcano in the State of Mexico (Singer, 1957). The remaining species are known from U.S.A., Costa Rica and Europe as was discussed.

The five major subdivisions of the genus are well represented in the country, as we show in table 1. Four are represented in coniferous forest and only P. singerii and the two species known until now in Mexico belonging to Section Subattenuata (P. latispora and P. oligoporpa), occur in coniferous as well as in mesophytic forests (this last also called subtropical forest because it is close related to the tropical forest). P. martinicensis also grows in a mesophytic forest and belongs to Section Versicolores.

Table 1. Sections and species of *Phaeocollybia* in Mexico

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1. SECT. SUBATTENUATA SING.

   Hyphae clamped; spores over 7.5 µm long.

   - *P. latispora* Guzmán, Bandala-Muñoz & Montoya-Bello
   - *P. oligoporpa* Sing.

2. SECT. RADICATAE SING.

   Hyphae clamped; spores no more 7.5 µm long.

   - *P. arduennensis* Bon

3. SECT. PHAEOCOLLYBIA

   Hyphae clampless; spores over 6.5 µm long.; cheilocystidia cylindric or clavate, never capitate.

   - *P. attenuata* (Smith) Sing.
   - *P. christinae* (Fr.) Heim
   - *P. fallax* Smith
   - *P. kauffmanii* (Smith) Sing.
   - *P. neosimilis* Sing.
   - *P. singerii* Guzmán, Bandala-Muñoz & Montoya-Bello.

4. SECT. VERSICOLORES SMITH

   Hyphae clampless, spores over 6.5 µm; cheilocystidia sublageniform and attenuated or capitate in the apex.

   - *P. californica* Smith
   - *P. lugubris* (Fr.) Heim
   - *P. martinicensis* Guzmán, Montoya-Bello & Bandala-Muñoz
   - *P. mexicana* Corner & Horak
   - *P. spoliata* Horak

5. SECT. MICROSPORAE SING.

   Hyphae clampless; spores no more 6.5 µm long.; cheilocystidia variable.

   - *P. hilaris* (Fr.) Heim

Figs. 34-37.- 34-35: *Phaeocollybia singerii*, cheilocystidia (Bandala-Muñoz 1008, Type). 36-37: *Phaeocollybia martinicensis*, cheilocystidia (Guzmán 16380, Type). Both X400.

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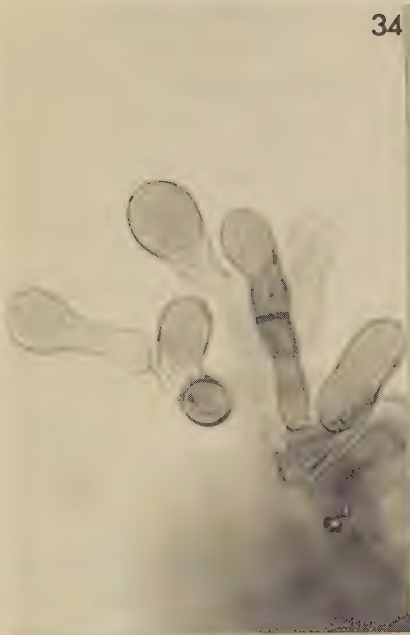

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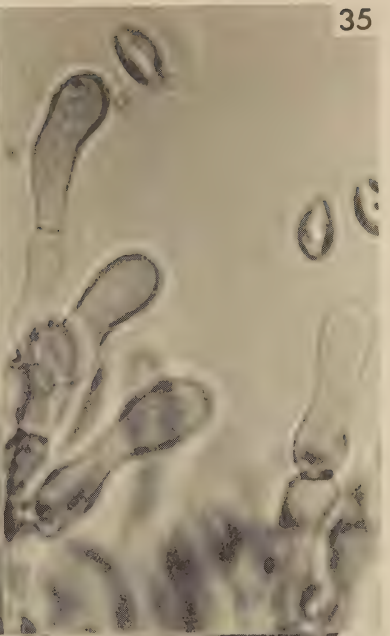

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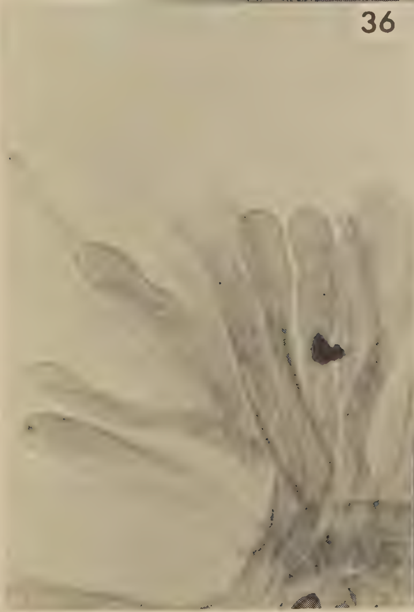

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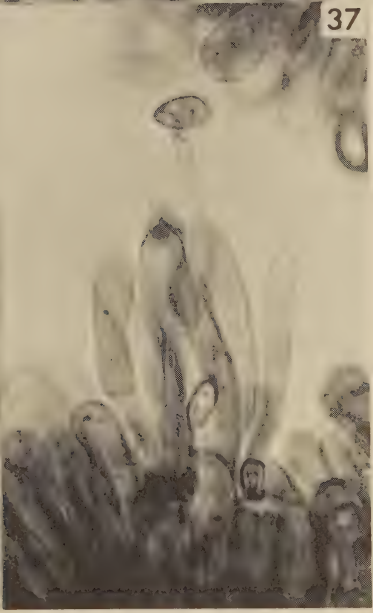

SYNOPTICAL KEY TO SPECIES OF *PHAEOCOLLYBIA* IN MEXICO

Species considered

1. *P. arduennensis*
2. *P. attenuata*
3. *P. californica*
4. *P. christinae*

*5. *P. fallax*

6. *P. hilaris*
7. *P. kauffmanii*
8. *P. latispora*
9. *P. lugubris*
10. *P. martinicensis*
11. *P. mexicana*

*12. *P. neosimilis*

13. *P. oligoporpa*
14. *P. singerii*
15. *P. spoliata*

* Neither species studied by the authors. Data for *P. fallax* were based on Smith (1957) and Horak (1976-1977) and those for *P. neosimilis* (as *P. attenuata* spp. *mexicana* Sing.) on Singer (1970).

Features taken in consideration:

Pileus diameter more than 40 mm	5,7,4
Pileus diameter up to 40 mm	1,2,3,4,6, 8, 9,10,11, 12,13,15
Pileus color	
gray olivaceous or olive brown	5,9
orange brown	1,2,3,4,6, 8,13,15
ochre brown	2,10,12,13

reddish brown	7,8,15
reddish orange	3
cinnamon brown	4,7
yellowish brown	4,7,9,10,13,14
vinaceous	11
gray brown	9,11
brown	6
chestnut brown	12
Pileus viscid	3,4,5,6,7,9,10,11,13,15
Pileus dry to lubricous	1,2,8,12,14
Lamellae subadnexed or subfree	2,3,4,5,6,7,8,9,10,11,12,13,14,15
Lamellae adnexed	1,11,13,15
Stipe up to 8 mm thick	1,2,3,5,6,8,9,11,12,15
Stipe broader than 8 mm	4,7,13,14
Spores	
small (up 8 µm long)	1,6
medium (no more than 10 µm long)	2,3,5,7,9,10,11,12,14
large (more than 10 µm long)	4,8,13,15
coarsely verrucose	8
minutely verrucose	2,3,4,5,7,9,11,12,13,15
verrucose punctate	1,6,10,14
Cheilocystidia	
clavate, cylindric or subfilamentous	2,4,5,7,8,12

ventricose, subventricose or subcylindric with a thin, long neck capitate	3,9,11
cylindric capitate or filamentous capitate	6
heteromorphy	1,10,13
clavate-subglobose, sublageniform of subutriform	14
sublageniform capitate or ventricose-fusoid capitate	15
frequently septated	2,4,7,12
frequently forked	1,9
Clamp connections	
absent	2,3,4,5,6,7,8,9,10,11,12,14,15
present	1,8,13
Habitat	
coniferous forest	1,2,3,4,5,6,7,8,9,11,12,13,15
mesophytic forest	10,13,14
Distribution	
D.F. (Federal District)	11

Durango	7,9
Guerrero	3
Hidalgo	7,8,9
Michoacan	7
Mexico State	6,12
Morelos	7,8,9,13
Veracruz	1,2,3,4,7,8, 10,11,13,14,15

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The authors express their thanks to Instito de Ecología and CONACYT for the financial support to this work. They also acknowledge to the Directors of the Herbaria ENCB, FCME and XAL for loan herbaria specimens. Dr. R. Singer and Dr. S. A. Redhead critically read the manuscript which is apreciated.

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TAXONOMICAL STUDIES ON USTILAGINALES. IV.

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ABSTRACT

New combinations proposed: Sphacelotheca rhei (Zundel) Vánky, based on Tilletia rhei (on Rheum franzenbachii); Sporisorium catharticum (R. Maire) Vánky, based on Sorosporium catharticum (on Cenchrus biflorus); Sporisorium guaraniticum (Speg.) Vánky, based on Ustilago guaranitica (on Schizachyrium condensatum).

The following names are considered synonyms: Cintractia caricis (Pers.) P. Magnus f. minor Camara & Oliveira (type on Carex pendula) is Farysia thuemenii (Fischer v. Waldheim) Nannfeldt. Doassansia lythropsidis Lagerheim (type on Lythrum hyspidulum), and D. peplidis Bubák (type on Lythrum volgense) are synonyms of D. punctiformis Winter (type on Lythrum hyssopifolia). Entyloma ludwigianum Sydow (type on Chrysanthemum segetum) is E. scalianum Ciferri (type on Chrysanthemum coronarium). Both Sphacelotheca titovii Golovin (type on Rheum maximoviczi), and Ustilago hsuii Wang (type on "Rumex" sp. = misnamed Rheum sp.) are Sphacelotheca rhei (Zundel) Vánky. The right name for Urocystis polygonati Moesz & Ulbrich (type on Polygonatum multiflorum) is Urocystis miyabeana Togashi & Onuma (type on "Convallaria majalis" = misnamed Polygonatum sp.). Ustilago ixiolirii Guo (type on Ixioliron tataricum) is Urocystis nevodovskyi Schwarzman (type on Ixioliron tataricum).

A lectotype is selected for Urocystis miyabeana Togashi & Onuma. A neotype is selected for Cintractia caricis (Pers.) P. Magnus f. minor Camara & Oliveira.

In this paper, further results of my taxonomical and nomenclatorial investigations on European and other smut fungi are presented.

Camara & Oliveira (1945:108) described Cintractia caricis (Pers.) P. Magnus f. minor Camara & Oliveira, on Carex pendula Huds. from Portugal, Prov. Estremadura, near Sao Pedro de Muel, VI.1940, coll. Pinto da Silva. Cintractia caricis, a collective name, is known today as Anthracoidea caricis (Pers.) Bref. The collective species A. caricis has been split into several species, each distinguished by small but constant morphological characters. The host range of each segregate species is restricted, usually, to a single section in the genus Carex (Savile 1952, Kukkonen 1963, Nannfeldt 1979, Vánky 1979). Consequently, I was interested in the identity of Cintractia caricis forma minor. Unfortunately, the holotype of C. caricis f. minor was destroyed (Isabel Saraiva, LISE, Oeiras, Portugal; in letter). However, there is another sample (LISE 24030), also on Carex pendula, (Portugal, Prov. Estremadura, near Sintra, Parque da Pena, 8.VII.1945, coll. M.L. Borges), identified by S. Camara as C. caricis f. minor. This sample is not mentioned in the protologue but it was cited by Camara later (1958:204), together with the holotype, in his Catalogus, under Cintractia caricis f. minor. I am proposing this specimen for neotype (LISE 24030!). Based on the description of Cintractia caricis f. minor ("Sporis valde minoribus, 4.5–10 x

3.5–7.5 µ"), and the study of the above-mentioned specimen, it is clear that this taxon refers to Farysia thuemenii (Fischer v. Waldh.) Nannf. (syn. F. olivacea (DC.) H. & P. Sydow), a smut fungus widely different from Anthracoidea (Cintractia) species.

The Doassansia species of Lythrum.

Common to all Doassansia species is the agglutination of hundreds of thin-walled, subhyaline spores into permanent balls surrounded by a cortex of sterile cells. The spore balls are embedded in the host tissue. Spore germination of Tilletia type (See also Vánky 1987:30).

In the course of 17 years, four names were published for Doassansias from different Lythrum species, all but one (no. 2) apparently without reference to the others. Their names are: 1) D. punctiformis Winter, 1886:207 (not Schröter, in Cohn 1887:287). 2) D. winteriana P. Magnus, 1891:253. 3) D. lythropsidis Lagerheim, 1889:127. 4) D. peplidis Bubák, 1903:51.

Of these names, D. winteriana was created due to a misinterpretation of the rule of priority by Magnus. The Winterian name, D. punctiformis, was validly published, one year earlier than that of Schröter's. Consequently, the Magnusian name is superfluous.

A study of the type specimens of D. lythropsidis and D. peplidis revealed no essential differences between them. On the contrary, it turned out that the morphological characters of the spore balls, spores and sterile cells are similar. Moreover, both specimens have an interesting and rather unusual morphological character, namely that the inner surface of the wall of the empty, cortical cells is provided with warts. Consequently, D. lythropsidis and D. peplidis must be considered conspecific.

The fourth, and oldest name is D. punctiformis. Winter (1886:207) provided this species with what was, for the time, a very good original description. He described the morphological characters of the sori, spore balls, spores and cortical cells, including the "minutissime granulata" cortical cells. These characters all fit very well with the results obtained by the study of the two above-mentioned type specimens. I had thought that the type specimen of D. punctiformis Winter was lost in Berlin, but later detected part of it in BPI under the name "Doassansia winteri P. Magnus". The study of this specimen confirmed that it is conspecific with the two, above-discussed species. Consequently, all four names of Doassansia on Lythrum represent a single species: D. punctiformis. Its description and synonyms follow:

Doassansia punctiformis Winter, 1886:207 (not Schröter, in Cohn 1887:287). D. winteriana P. Magnus, 1891:253, nomen novum superfluum. Type on Lythrum hyssopifolia L., Australia, Victoria, near Melbourne, 20.X.1885, coll. Reader (140; BPI 178786!). – D. lythropsidis Lagerheim, 1889:127. Type on Lythropsis peploides Welwitsch ex Koehne (= Lythrum hispidulum (Dur.) Koehne), Portugal, "inter Torre et Perum, tr. Tagum", July, coll. F. Welwitsch (LISU!). – D. peplidis Bubák, 1903:51. Type on Peplis alternifolia Bieb. (= Lythrum volgense D.A. Webb), Bulgaria, between Haskovo and Haskovo spa, VI.1900, C.J. Podpera (BPI!).

Sori in leaves forming first yellowish-, later dark brown spots in which the scattered or gregarious spore balls appear as minute, dark brown, punctiform, amphigenous elevations. Spore balls embedded in the host tissue, 150–250 µm in diameter, composed of a central mass of more or less firmly united spores surrounded by a cortex of usually a single layer of sterile cells. Spores globose, rounded polyangular, ovoid, somewhat irregular of mutual pressure, 8–11(–12) x 9.5–15(–16) µm, pale yellow; wall thin (c. 0.5 µm), smooth. Cortical cells variable in form and size, irregularly polyhedral, 8–20 µm long, yellowish-brown; wall 1–1.5(–2) µm thick, often (especially in the large cells) prominently echinulate on the inner surface with spines up to 1 µm high.

On Lythraceae: Lythrum spp. (L. hyspidulum Koehne, L. hyssopifolia L., L. volgense D.A. Webb), Europe (Bulgaria, France, Portugal), Australia. Probably more common but overlooked.

Entyloma ludwigianum Sydow is *E. scalianum* Ciferri.

Ciferri (1924:49) described *Entyloma scalianum*, on *Pinardia coronaria* (L.) Less. (= *Chrysanthemum coronarium* L.) from Italy, Sicilia, prov. Catania, Mascalucia, II.1901, coll. Scalia; isotypes in Saccardo, Mycotheca italica 720 (HUV 1222!). Sydow (1932:396) published *Entyloma ludwigianum*, on *Chrysanthemum segetum* L., from Germany, Westfalen, Kreis Siegen, near Dirlenbach, 8.VIII.1931, A. Ludwig; isotypes in Sydow, Mycotheca germanica 2508 (HUV 9793!). The comparison of the two isotypes revealed no morphological differences between the spores or sori of these two species. Consequently, I consider them conspecific.

Sporisorium catharticum (R. Maire) Vánky, comb. nov. Basionym: *Sorosporium catharticum* R. Maire, In Recueil de traveaux cryptogamiques dédiés à Louis Mangin, 1931, p. 359. Type on *Cenchrus catharticus* Delile (= *C. biflorus* Roxb.), Algeria, South Sahara, near Tilemsi, coll. T. Monod (467; MPU!).

Sori in hypertrophied ovaries covered with a delicate, greyish-brown peridium which flakes away exposing the semiagglutinated to granular-powdery mass of spore balls and a short, central columella. Spore balls globose to elliptical, 40–110 µm long, dark reddish-brown, composed of a great number of spores which separate rather easily. Spores on the periphery of the balls globose to elliptical, 9–13 x 10–14.5 µm, medium reddish-brown, finely and densely echinulate, those in the center subpolyhedral, smaller (7–10 µm), lighter colored and finely pitted or apparently smooth. Sterile cells of the peridium variable in form and size, often elongated, 4–16 µm long, arranged in parallel chains, hyaline, smooth.

Based on the descriptions, *S. catharticum* could be conspecific with *Ustilago penniseti* Rabenhorst (type on *Pennisetum fasciculatum* Trin. = *P. orientale* Rich.). Rabenhorst (1871:18) described his species as being smooth-spored whereas spores of *Spor. catharcticum* are pitted to finely echinulate. Probably, the spores of *U. penniseti* are also echinulate but the fine ornamentation was beyond Rabenhorst's 1871 limit of resolution. Reexamination of type material of *U. penniseti* is necessary to resolve this problem.

Sporisorium guaraniticum (Spegazzini) Vánky, comb. nov. Basionym: *Ustilago guaranitica* Spegazzini, Anales Soc. Ci. Argent. 17:87, 1884. Syn. *Sphacelotheca guaranitica* (Speg.) Zundel, 1930:135. Type on *Andropogon condensatus* H.B.K. (= *Schizachyrium condensatum* (H.B.K.) Nees, Paraguay, between Paraguari and Valenzuela, V.1883 ("HMAS"!).

Sori destroy the racemes and are 2–3 cm long, linear, partly hidden by the spathes, covered by a thin membrane which ruptures disclosing the blackish-brown, granular-powdery mass of spore balls and a long, thin, slender, central columella. Spore balls loose, subglobose to long ellipsoidal, 50–120 µm long, dark reddish-brown. Spores subglobose, usually ellipsoidal or slightly irregular, 12–16 x 13–20 µm, light to medium reddish-brown, free surface of the outer spores with fine, dense verrucae just affecting the spore profile, inner spores smooth; wall typically unevenly thickened, with (0–)2–4(–6) protuberances or thicker and darker areas (0.8–2.5 µm) alternating with thin and light areas of the spore wall (0.5–1 µm).

The identity of *Tilletia rhei*.

From the mycological herbarium of the Institute of Microbiology of the Chinese Academy of Science ("HMAS"), I obtained in exchange a fragment of the holotype of *Ustilago hsuii* Wang, collected on "*Rumex*" sp. in China. The study of this specimen revealed that the host is actually a *Rheum* sp. /On the fruits of the host plant, up to 8 stamens are detectable (*Rheum* has 9 stamens; *Rumex* 6), the stigmata are head-like (as in *Rheum*) and not brush-like (typical for *Rumex*), furthermore, the inner segments of the perianth are not enlarged as they would be in ripe fruits of *Rumex* (R. Bernt, pers. comm.)/ and its smut is identical with

"*Tilletia*" *rhei* Zundel.

Zundel (1944:410) described *Tilletia rhei* from the seeds of *Rheum franzenbachii* Mürt, collected in China. *T. rhei* is characterised by sori in the seeds, swollen, 2–4 mm in diameter, covered by a hard, dark reddish-brown, somewhat shiny pericarp lined by a whitish layer of immature spores. Sori open from their apices, like tulips, to reveal the agglutinated, purplish-black mass of spores, and a central, irregular columella which also produces spores. Spores variable in size and grade of maturity, mature ones globose, subglobose or ellipsoid, rarely elongated or somewhat irregular, 13–22 x 15–24 µm, violet tinted reddish-brown; spore surface variously sculpted: from very finely reticulate (9–18 meshes per spore diameter), with uniformly thick muri or with verrucose thickenings in the common points of the meshes to only verrucose by the reduction and disappearance of the muri; wall 2.5–3.5 µm wide including the 1–1.5 µm high reticulum. Sterile cells (or immature spores?) larger than the spores, hyaline, thick-walled, smooth.

Golovin (1950:10) described *Sphacelotheca titovii* in the seeds of *Rheum maximoviczi* A. Los., from Kazakhstan. The description of this species agrees with that of *Tilletia rhei*. I have not seen the type of *S. titovii*, but I have studied one collection on *Rheum maximoviczi* from Tadzhikistan (AA), and another on *R. wittrockii* Lundstr. from Kazakhstan (AA). Both agree with the type of *T. rhei*. (The sorus diameter given by Golovin as 26–30 mm refers certainly to 2.6–3.0 mm). Following germination, Golovin (1950:10) obtained a 3–4-celled promycelium giving rise to hyphae.

Production of a septate promycelium excludes "*Tilletia*" *rhei* from the genus *Tilletia*. I am proposing for it the following name and synonyms:

Sphacelotheca rhei (Zundel) Vánky, comb. nov. Basionym *Tilletia rhei* Zundel, Mycologia 36:410, 1944. Type on *Rheum franzenbachii* Mürt (= *R. rhabarbarum* L.), China, Shanshi prov., Chiao-Ch'eng distr., Yünting-Shan, 2500 m, 2.IX.1924, H. Smith (Plantae sinenses 7451; S!, UPS!). – *Sphacelotheca titovii* Golovin, in Sredneaz. Gos. Univ., N.S., Publ. XIV, Biol. Nauk. Book 5:10, 1950. Type on *Rheum maximoviczi* A. Los., USSR, Kazakhstan, valley of Karapchur river, Myndzhelike, south from Bol'shoi Tsimgan, 2700 m, V. Titov. – *Ustilago hsuii* Wang, in Acta Bot. Sinica 10:133, 1962. Type on "*Rumex*" sp. (= misnamed *Rheum* sp.), China, Sinkiang prov., Barto muchong, alt. 2100 m, 30.VIII.1958, Hsu Lian-wang (377; HMAS 31558, HUV 13602!).

The identity of *Ustilago ixiolirii* Guo.

Guo recently (1988:222) published a new smut species from China, under the name *Ustilago ixiolirii*, producing its sori in the capsules of *Ixioliron tataricum* (Pall.) Herb. (Amaryllidaceae). On examination, part of the holotype ("HMAS" 51934, obtained courtesy of Mrs L. Guo), prowed to be identical to the type of *Urocystis nevodovskyi*, described by Schwarzman (1960:327) on *Ixioliron tataricum*, from Kazakhstan. The "cerebriform surface" of the "spores" of "*Ustilago ixiolirii*" is actually produced by the numerous, small, collapsed, hyaline sterile cells which surround completely the 1(–2–3) central, fertile spores in the spore balls. Consequently, *Ustilago ixiolirii* Guo is a synonym of *Urocystis nevodovskyi* Schwarzman.

Urocystis miyabeana instead of *Urocystis polygonati*.

Togashi and Onuma (1930:25) published a new *Urocystis* species, *U. miyabeana*, "on leaves and sheaths of *Convallaria majalis* L., Japan, Prov. Rikuchu, Mt. Himekami, June 1 & 15, 1928, K. Togashi and F. Onuma". No one since has reported *Urocystis* species on *Convallaria*. My repeated attempts to find this smut in different parts of the world failed. However, one should keep in mind, that *Urocystis* species on Liliaceae often are very rare, even where the host plants are growing in abundance. There is no specimen of *U. miyabeana* in the Herbarium of Plant Pathology Laboratory, Faculty of Agriculture, Iwate University, Morioka. The "Type", collected on 15.VI.1928, originating from

"Herbarium Kogo Togashi No. 3927" is in Sapporo (SAPA). Several infected plants from the type had, however, the leaf characters of Polygonatum rather than those of Convallaria. Unfortunately no rhizomes were collected. A good differentiating character for these two genera is, i.a., that the leaves of Convallaria arise from the rhizome, while in Polygonatum and the host plants of U. miyabeana, they arise from the stem. The spore balls and spores of the types of these two Urocystis species are also similar. These facts indicate that the two names are taxonomical synonyms. The right name and the synonyms of this Polygonatum smut are:

Urocystis miyabeana Togashi & Onuma (1930:25). – Tuburcinia miyabeana (Togashi & Onuma) Togashi, in Ito (1935:95). Lectotype on "Convallaria majalis" (= misnamed Polygonatum sp.), Japan, Rikuchu Province (= Iwate Prefecture), Mt. Himekami, (sel. here) 15.VI.1928, F. Onuma (SAPA!). – Urocystis polygonati Moesz & Ulbrich (1941:395). Lectoype on Polygonatum multiflorum (L.) All., Hungary, Budapest, Mt. Jánoshegy, (sel. by Vánky 1985:174) 11.VI.1927, G. Moesz (BP!). – Tuburcinia polygonati Lavrov (1937:3). – Urocystis polygonati (Lavrov) Zundel (1953:330; later homonym). – Urocystis polygonati (Lavrov) T. Săvulescu (1957:1071; later homonym). Type on Polygonatum officinale All., USSR, Sibiria, region Zabaykal, near Ust.-Kiran, 3.VI.1913, P. Mikhno (LEP!). – Urocystis ungeri Zundel (1945:372). Lectotype on Polygnatum multiflorum (L.) All., (sel. by Zundel 1953:336) Czechoslovakia, Moravia, Doubrava, 14.V.1898, F. Bubák (BPI!). – Tuburcinia polygonati Mayor & Viennot-Bourgin (1948:11; later homonym). Type on Polygonatum verticillatum (L.) All., France, Mt. Jura, Joux forest, 1.VI.1947, E. Mayor.

From the two collections of Urocystis miyabeana, mentioned in the protologue ("June 1 & 15, 1928."), I could detect in Japan only one, namely that collected on 15th of June by F. Onuma, which I select as lectotype (SAPA!).

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ABBREVIATIONS

The abbreviations for herbaria follow Index Herbariorum (Stafleu et al. 1981).

HMAS = Herb. Mycol. Acad. Sinica, Beijing.

HUV = Herb. Ustilag. Vánky, the author's private herbarium.

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A NEW COMBINATION FOR HELMINTHOSPORIUM EUPHORBIAE

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A new Bipolaris combination is presented for Helminthosporium euphorbiae Hansford, 1943.

Considerable attention has been given in the past decade to the taxonomy of species of Helminthosporium Link:Fries **sensu lato** which produce conidia upon geniculate conidiophores (Alcorn, 1983; Muchovej et al., 1988; Sivanesan, 1987). A majority of these species are pathogenic to grasses and many represent major pathogens of cereals (Zillinsky, 1983) and amenity grasses (Couch, 1973). However, a few species appear to be limited to dicotyledonous hosts and these have received little attention taxonomically. Among these is Helminthosporium euphorbiae Hansford, which produces a leaf spot of Euphorbia spp. which can cause defoliation of these plants.

The genus Helminthosporium was originally divided based on the presence of macronematous erect conidiophores which produced enteroblastic conidia terminally and from pores located below the septa of the conidiophore; or on the presence of macronematous erect conidiophores which produce enteroblastic conidia singly at the apex followed by sympodial branching (Ellis, 1971). The former were retained in Helminthosporium while the latter were placed in Drechslera Ito (1930). Drechslera was further subdivided into Bipolaris Shoemaker (1959) and Exserohilum Leonard & Suggs (1974) based on bipolar germination and the presence of a protuberant hilum respectively.

Alcorn (1983) after studying a vast majority of the species of Drechslera, Bipolaris and Exserohilum found that the generic concepts of these were sound.

A few species remain undisposed by this changing classification (Muchovej, et al., 1988) and we have found one such species producing leaf spots of Euphorbia in Brazil. Based on morphological characteristics, our species agrees with descriptions of Helminthosporium euphorbiae Hansford (1942) [Drechslera euphorbiae (Hansford) M. B. Ellis (Ellis, 1971)]. Based on the characteristics described by Alcorn (1983), this species should be transferred to Bipolaris.

Bipolaris euphorbiae (Hansford) Muchovej comb. nov.
- *Helminthosporium euphorbiae* Hansford, 1943, Proc. Linn. Soc. London 1942-43:49.
- *Drechslera euphorbiae* (Hansford) M. B. Ellis, 1971, Dematiaceous Hyphomycetes, pg 440.

Brazil, Viçosa, MG, on leaves of *Euphorbia* sp., March 1988, Herbario UFV neotypus (ATCC 64939, BRIP ex neotypus). Other collections were deposited at BRIP 16567. Attempts to obtain Hansford's type (number 1230) have confirmed that it is not housed at PREM, IMI or BRIP, therefore a neotype has been designated.

Conidia are light to mid brown in color with the tips often lighter in color. They are subcylindrical to fusiform, rounded at the ends, often slightly flexed, and widest near the middle. Germination is bipolar with the germ tube originating near the hilum and proceeding along the long axis of the conidium. The first septum is produced about one third the way up the conidium from the hilum, the second septum delimits the basal cell and the third septum is distal to the first. Conidia are 63-96(-145) x 14.7-17.5 um and typically 7-8 distoseptate, with only a small number of conidia having fewer or more septa. The hilum is truncate and 2.3-3.8 um wide. Conidiophores are geniculate in and have a clear apex which was flattened. There was no significant variation between conidia produced on the host or in culture.

These characteristics fit well in those for *Bipolaris*. Alcorn (1983) inspected a collection of *H. euphorbiae* (IMI 161577) from which he alluded that this species showed characteristics of *Bipolaris*.

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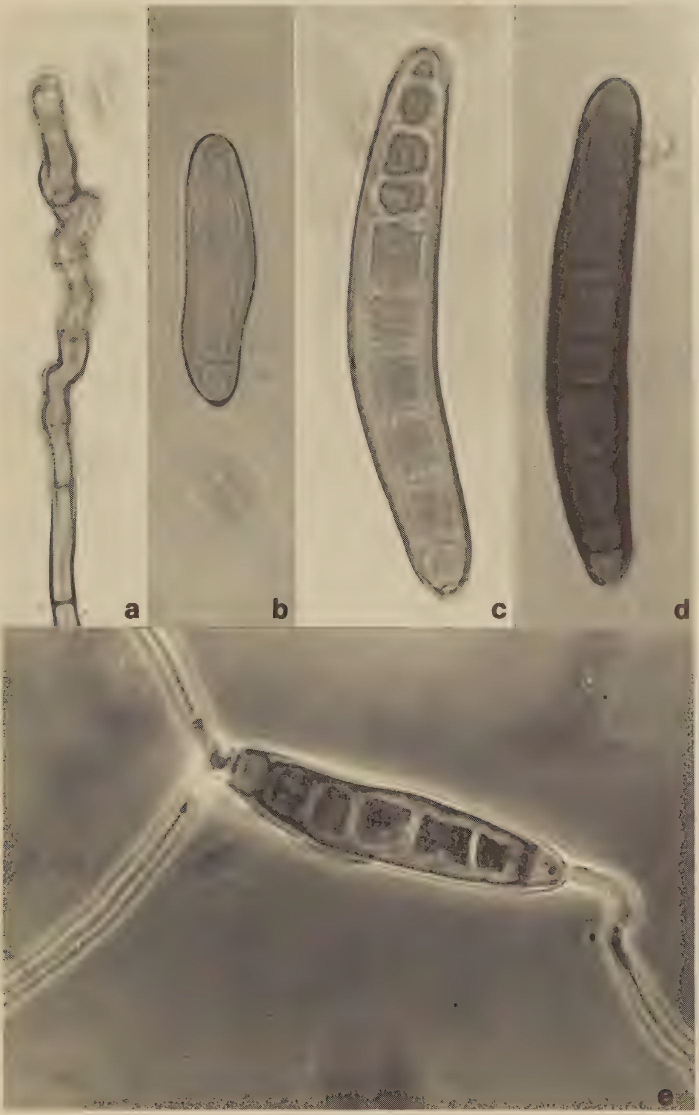
Figure 1. *Bipolaris euphorbiae* x 700. a) geniculate conidiophore, b) forming conidium with 3 septa, c,d) conidia, e) germinating conidium.


a
b
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d
e

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TWO NEW SPECIES OF LABOULBENIA (LABOULBENIALES) PARASITIC ON ENDOGEAN CARABID BEETLES

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SUMMARY

Two new species of *Laboulbenia* (Laboulbeniales, Ascomycotina) parasitic on endogean carabid beetles (Coleoptera, Carabidae) are described and illustrated: *L. reicheiae* sp. nov. on *Reicheia* spp. (Coleoptera, Carabidae, Scaritinae) from Spain, France and Algeria and *L. speluncae* sp. nov. on *Iberanillus vinyasi* Español (Coleoptera, Carabidae, Bembidiinae, Anillini), from Spain.

INTRODUCTION

The genus *Laboulbenia* Montagne & Robin in Robin is the largest in number of taxa among the laboulbeniaceous fungi, with more than 500 species described. *Laboulbenia* species chiefly parasitize carabid beetles, but they also occur on other families of Coleoptera and other groups of arthropods. *Laboulbenia* is a cosmopolitan genus (Tavares, 1985).

The two new species proposed here have some morphological peculiarities which distinguish them from most of the other species of *Laboulbenia*. However, the species are being placed in *Laboulbenia* because of the perithecial wall, the position of the primary septum, the structure of the upper receptacle, and the production of an evanescent antheridium from the first cell of the appendage.

DESCRIPTIONS

Laboulbenia reicheiae Santamaria, sp. nov. (figs. 1-9)

Coloratio generalis porphyrea, cellula I clarior. Cellula II subdivisa in alias duas cellulas aequales altitudine. Cellula IV parva, caulicuneata versus cylindrica, a cellula III separata septo obliquo. Cellula V fusiformis versus cuneiformis, longa et angusta, limitem inferiorem cellulae III fere attingens. Septum IV-V longitudinale. Cellula VI cuneiformis, maxime parva. Perithecium fusiforme, apicem detruncatum versus rotundatum habens. Septum primarium intense pictum brunneo, constrictionem in cellula IV formans. Appendix primaria simplicissima, inconspicua, cellulam basalem intense pictam habens.

Tota longitudo: 100-118 µm. Perithecium: 42-58 µm x 19-27 µm. Ascosporae: 25 µm.

Holotypus: SS513, BCB-Mycotheca. Super Reicheia lucifuga, Le Perthus incolente (Gallia Narbonense).

Overall color pale red brown, with the basal cell (I) nearly hyaline.

Receptacle: Suprabasal cell (II) subdivided into two cells of equal length. Cell IV small, superimposed on cell III, truncated cone to cylindrical, separated from cell III by an oblique septum. Cell V spindle-shaped or wedge-shaped, long and narrow, nearly reaching the lower margin of cell III. Septum IV-V longitudinal.

Appendage: Primary septum deeply pigmented, marked by a constriction over cell IV. Primary appendage simple, with the basal cell deeply pigmented but not flattened (therefore is not the typical insertion cell named melanopsallium). The primary appendage, in spite of appearing damaged in all specimens, is very short and simple and, in my opinion, doesn't develop more than is illustrated in the figures (cf. figs. 2, 4). Probably, the terminal cell of the short branch arising from the internal side of the primary appendage acts as a single antheridium (figs. 3-5); its position over the brief trichogyne would be in accordance to its spermatic function. The antheridium degenerates when the perithecium matures.

Perithecium: Stalk cell (VI) wedge-shaped, very short. Body of the perithecium elliptical, with a truncated or rounded apex. In each vertical row of outer wall cells of the perithecium there are 4 cells of unequal height. The ventral surface of the perithecium is marked by a prominence due to the septum which separates the two lower wall cells.

Measurements: Perithecium, 42-58 µm x 19-27 µm. Total length, 100-118 µm. Ascospores, 25 µm.

Etymology.- Named after *Reicheia*, generic name of the host.

Holotype.- FRANCE: Le Perthus (Pyrénées orientales). On elytron of *Reicheia lucifuga* Saulcy (Coleoptera, Carabidae, Scaritinae, Reicheini). Entomological collection of the "Museu de Zoologia de Barcelona" (Spain). BCB-Mycotheca, SS513.

Other material examined.- SPAIN: La Rabassada (Barcelona, Catalunya), 25-V-17. On elytron and pronotum of *Reicheia lucifuga* ssp. *zariquieyi* Holdhaus. Entomological collection of the "Museu de Zoologia de Barcelona" (Spain). SS615, sent to Dr. I. I. Tavares herbarium.

Vallvidrera (Barcelona, Catalunya), XI-15. On elytron and legs of *Reicheia lucifuga* ssp. *zariquieyi* Holdhaus. Entomological collection of the "Museu de Zoologia de Barcelona" (Spain). BCB-Mycotheca, SS616.

Riells del Fai (Barcelona, Catalunya). On elytron of *Reicheia lucifuga* ssp. *zariquieyi* Holdhaus. Entomological collection of the "Museu de Zoologia de Barcelona" (Spain). BCB-Mycotheca, SS617.

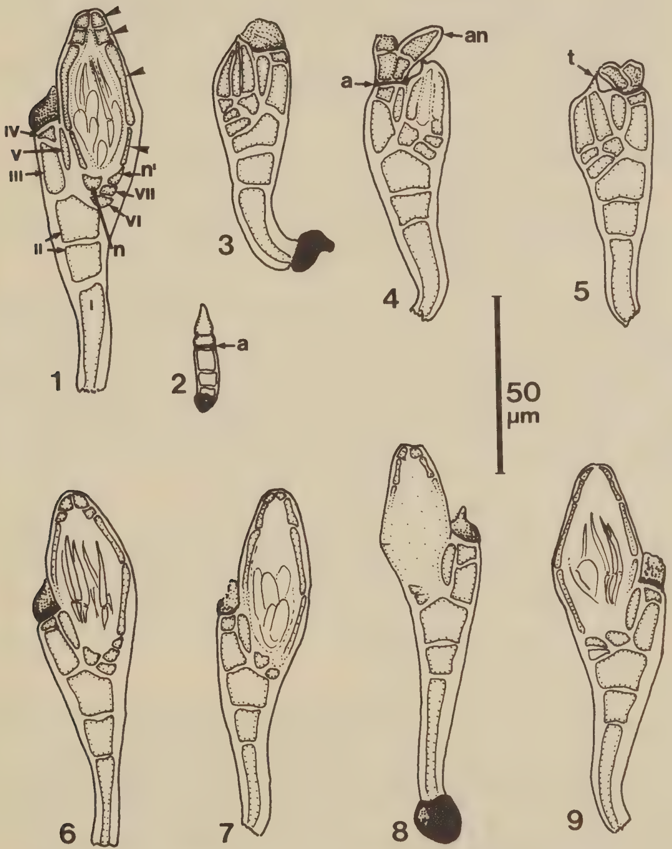
FRANCE: Morellàs (Pyrénées orientales). On elytron and legs of *Reicheia lucifuga* Saulcy. Entomological collection of the "Museu de Zoologia de Barcelona" (Spain). BCB-Mycotheca, SS614.

Montbollo (Pyrénées orientales), IV-65, leg. Tempère. On elytron of *Reicheia lucifuga* Saulcy. Herbarium J. Balazuc.

ALGERIA: Bou-Berak (Kabylie). On elytron of *Reicheia brisouti* Bedel. Entomological collection of the "Museu de Zoologia de Barcelona" (Spain). BCB-Mycotheca, SS613.

Bosc d'A-kahcra, 23-II-55, leg. de Miré. On left elytron of *Reicheia kabyliana* ssp. *quezeli* Miré. Herbarium J. Balazuc.

Bosc de Guerrouch, 21-II-55, leg. de Miré. On right elytron and pronotum of *Reicheia subterranea* ssp. *saldoensis* Miré. Herbarium J. Balazuc.



Figures 1-9. *Laboulbenia reicheiae*. **1**. Mature holotype (SS513). General arrangement of cells. Arrows indicate the wall cells of the perithecium. **2**. Immature specimen. a, primary septum. (SS616). **3-5**. Immature specimens showing the antheridium (an) and trichogyne (t). (SS613). **6-9**. Mature specimens. (6, SS513, holotype; 7, SS615; and 8-9, SS616).

Laboulbenia speluncae Santamaria, sp. nov. (figs. 10-17)

Cellula I apicem perithecii et extremam appendicem primariam hyalinus habet. Thallus reliquus fuscus, parvas maculas obscuriores in receptaculo habens. Cellula I subdivisa in alias duas cellulas, inferiorem minorem quam superiorem. Cellula III-IV indivisa. Cellula V cuneiformis, a cellula III-IV disjuncta septo obliquo. Cellula VI valde applanata. Perithecium fusiforme, apicem indistinctum habens. Septum primarium constrictionem bene notatam format super cellulis III-IV et V, praeter intense pictum brunneo. Cellula insertionis absens. Basis appendicis primariae duabus cellulis inaequalibus et intense pictis fusco formata; cellula externa maxima est, et basem appendici simplici format, bicellulari vel tricellulari, nunquam superanti in longitudine apicem perithecii; cellula interna valde parva est, et, in exemplis immaturis, brevem appendicem uno antheridio terminatem sustinet; haec appendix interna caduca est.

Longitudo unguis-apex perithecii: 72-105 µm. Perithecium: 39-48 (-57) µm x 13-25 µm. Ascosporae: 37 µm.

Holotypus: SS216/1a. BCB-Mycotheca. Super Iberanillo vinyasi, Cueva Hondero incolente, Ahín, in provincia Castellón (Valentino regno, Hispania).

Cell I, apex of perithecium and top of primary appendage hyaline. Remainder of thallus brown, with small dark spots in the receptacle.

Receptacle: Suprabasal cell (II) subdivided into two cells, the lower being smaller than the upper. Cell III-IV undivided. Cell V wedge-shaped, separated from the undivided cell III-IV by an oblique septum.

Appendage: The primary septum is marked by a constriction over cells III-IV and V, and is deeply pigmented. The typical flattened insertion-cell (melanopsallium) is absent. The base of the primary appendage is made up of two unequal, dark-colored cells; the external cell is the largest and supports a simple bi- or tricellular branch; the branch does not reach the top of the mature perithecium; the internal basal appendage cell is very small and bears, in immature specimens, a short branch with a single apical antheridium (fig. 11); this internal branch is deciduous.

Perithecium: Stalk cell (VI) short. Body of the perithecium elliptical. In each vertical row of outer wall cells of the perithecium there are 4 cells of unequal height. Secondary stalk cell (VII) and basal cells (m, n, n') of the perithecium very small but easy to observe on immature specimens.

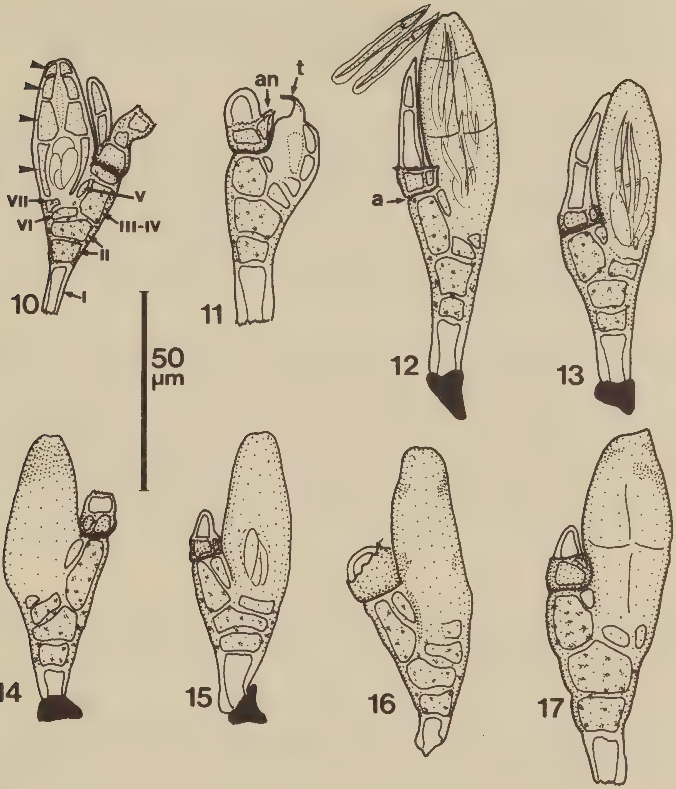
Measurements: Perithecium, 39-48 (-57) µm x 13-25 µm. Total length, 72-105 µm. Ascospores, 37 µm.

Etymology.- From spelunca, cave, referring to the habitat of the host and its parasite.

Holotype.- SPAIN: Cova Hondero, Ahín (Castelló), 25-IX-77. On *Iberanillus vinyasi* Español (Coleoptera, Carabidae, Bembidiinae, Anillini). Entomological collection of the "Museu de Zoologia de Barcelona" (Spain). BCB-Mycotheca, SS216/1a.

Isotypes.- SPAIN: Ibidem, 25-IX-77. On the same host. Entomological collection of the "Museu de Zoologia de Barcelona" (Spain). BCB-Mycotheca, slides SS216a, SS216b, SS216/1b.

Paratypes.- SPAIN: Ibidem, 13-XII-78. On the same host. Entomological collection of the "Museu de Zoologia de Barcelona" and entomological collection of J. Comas. BCB-Mycotheca, slides SS216c and SS216d. Slide SS541 sent to Dr. I. I. Tavares herbarium.



Figures 10-17. *Laboulbenia speluncae*. **10**. Mature isotype (SS216b), general arrangement of cells. Arrows indicate the wall cells of the perithecium. **11**. Immature specimen showing the antheridium (an) and the trichogyne (t). (SS216/1b, isotype). **12-15**. Mature specimens (SS216/1a, holotype). a, primary septum. **16**. Mature isotype (SS216b). 17. Mature paratype (SS216c).

All slides of *Laboulbenia reicheiae* and *Laboulbenia speluncae* mentioned here are in: BCB-Mycotheca (Herbarium of the "Departament de Biologia Animal, Biologia Vegetal i Ecologia, Unitat Botànica, Universitat Autònoma de Barcelona"); personal herbarium of Dr. J. Balazuc, and personal herbarium of Dr. I. I. Tavares (slides SS615 and SS541). The hosts are in the entomological collection of the "Museu de Zoologia de Barcelona", the entomological collection of J. Comas and the J. Balazuc collection.

DISCUSSION

The two *Laboulbenia* species proposed here have significant morphological similarities: (1) suprabasal cell of receptacle (II) divided into two cells by a transverse septum, (2) lack of a black, flattened insertion cell (melanopsallium), (3) compact primary appendage with a single deciduous antheridium and, (4) a modified thallus like other endogean *Laboulbenia* species (e.g. *Laboulbenia coiffaitii*).

Laboulbenia reicheiae parasitizes *Reicheia* spp. from Spain, France and Algeria. On *Reicheia* we find *Scalenomyces endogaeus* (Picard) Tavares (= *Laboulbenia endogaea* Picard, cf. Tavares, 1985) and *Laboulbenia pedicellata*. The former is a highly modified species related to *Laboulbenia* and some allied, undescribed taxa (Tavares, 1985). *Laboulbenia pedicellata* is a common, ubiquitous species. *Laboulbenia reicheiae* doesn't agree with the *Scalenomyces* description because of the short primary appendage and its distinctive receptacular structures.

Laboulbenia speluncae parasitizes *Iberanillus vinyasi* Español, a small endogean carabid beetle, endemic in Cova Hondero in the Central part of eastern Spain. The genus *Iberanillus* belongs to the tribe Anillini (Carabidae); several laboulbeniaceous fungi are known on this group, among them *L. coiffaitii* Balazuc (1971) which differs from *L. speluncae* because of its long primary appendage, separate cells III and IV, and its single suprabasal cell (II). In Santamaria (1986) I misidentified this material as *L. coiffaitii*; its comparison with the type of *L. coiffaitii* (sent to me by Dr. Jean Balazuc) convinced me of the necessity to describe this new taxon.

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CHEMICAL VARIATION IN THE LICHEN LECANORA EPIBRYON S. AMPL. (LECANORACEAE: ASCOMYCOTINA)

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ABSTRACT : A total of 20 lichen substances were detected in collections of *Lecanora broccha* from the Southern Hemisphere. These substances occurred in 14 combinations within this species, but a phenetic comparison of the races using the chemical data and their distribution did not show any clear pattern. *L. broccha* appears to be morphologically indistinguishable from the Northern Hemisphere species *L. epibryon,* but for the present they are maintained as distinct species because of their chemical dissimilarities and distinctive geographic distributions.

Natural product chemistry has played an important role in lichen taxonomy ever since Nylander (1866) introduced chemical reagents as an aid for the identification of lichen species. Current concepts in lichen chemotaxonomy and the alternative views on the taxonomic value of chemical characters have been reviewed recently by Egan (1986) and Culberson (1986).

While most species are characterized by a constant combination of lichen substances irrespective of their geographic origin, others are not. Indeed in some cases no correlation between chemical constituents and geography or morphology are apparent. Such species include *Cetraria islandica* (L.) Ach. (Kärnefelt 1979) and *Pertusaria oculata* (Dicks.) Th. Fr. (Dibben 1980).

In the course of conducting a detailed comparison of *Lecanora broccha* Nyl. [syn.: *L. parmelina* Zahlbr. according to Galloway, who gives a detailed description of this taxon (Galloway 1985)] from the Southern Hemisphere with the circumpolar Northern Hemisphere *L. epibryon* (Ach.) Ach. (Brodo 1984), we examined the chemical constituents of both species. In contrast to *L. epibryon, L. broccha* exhibited very variable chemistry throughout its broad geographic range. The secondary metabolites, their distribution and the relationship between *L. epibryon* and *L. broccha* are discussed.

Material and Methods

Lichen material from the following herbaria was examined: ANUC, BM, HO and herb. Lumbsch. The lichen fragments were freed of all obvious organic substrate material and extracted with warm acetone for thin layer chromatography (t.l.c.), or with warm methanol for high performance liquid chromatography (h.p.l.c.). T.l.c. analyses were conducted using the standardized methodology developed by Culberson (Culberson 1972; Culberson & Johnson 1982; Culberson, Culberson & Johnson 1981; Elix, Johnston & Parker 1987, 1988). H.p.l.c. was performed using a Perkin-Elmer Series 1LC pump fitted with a HS-5 C18 column and a LC-85 spectrometric detector operating at 254 nm. Elution was effected with 90% methanol-water containing orthophosphoric acid (80µl/400ml) with a flow rate of 0.6 ml min^{-1} (Lumbsch & Elix 1985).

Phenetic comparison of the chemical races was carried out with the computer program MANHATT (Mietzsch, unpubl.). The distance of the OTU's was measured in Manhattan distance. The similarities were demonstrated by a phenogram using the single-linkage cluster analysis of Estabrook (1966).

Results and Discussion

The species *L. epibryon* and *L. broccha* are morphologically indistinguishable and show no substantial differences in their anatomy. However where the Northern Hemisphere populations (*L. epibryon*) has a relatively uniform chemistry, the Southern Hemisphere specimens (*L. broccha*) exhibit remarkable chemical diversity.

The following lichen substances were identified in the specimens examined.

β-Orcinol Depsides : atranorin (1), chloroatranorin (2), barbatic acid (3), 4-*O*-demethylbarbatic acid (4), methyl barbatate (5).

β-Orcinol Depsidones : connorstictic acid (6), constictic acid (7), cryptostictic acid (8), hypoprotocetraric acid (9), menegazziaic acid (10), norstictic acid (11) and stictic acid (12).

Orcinol Depsides : lecanoric acid (13).

Xanthones : unknown xanthones x-1 (14), x-2 (15), thiophanic (16), x-4 (17) and isoarthothelin (18).

Triterpenoids : Lgr-1* (19), Lgr-2* (20), zeorin [hopan-6α,22-diol](21) and ursolic acid (22).

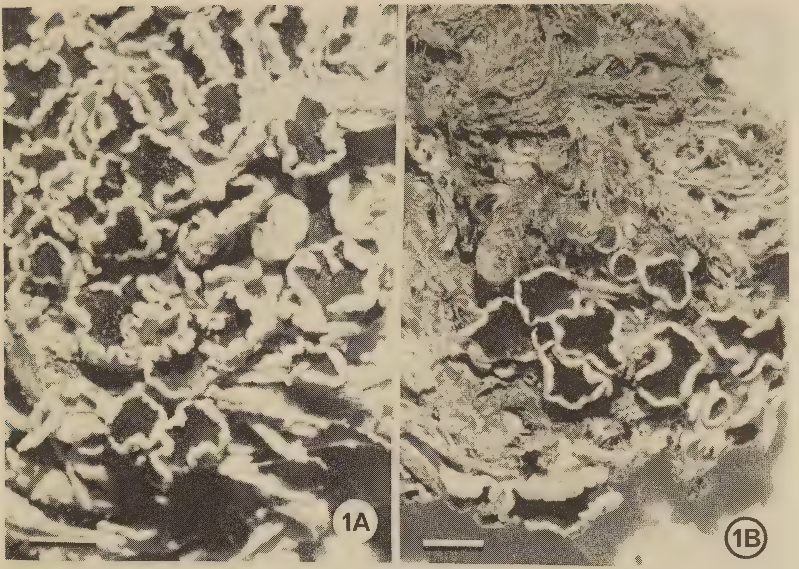
β-Orcinol Derivative : methyl β-orsellinate (23).

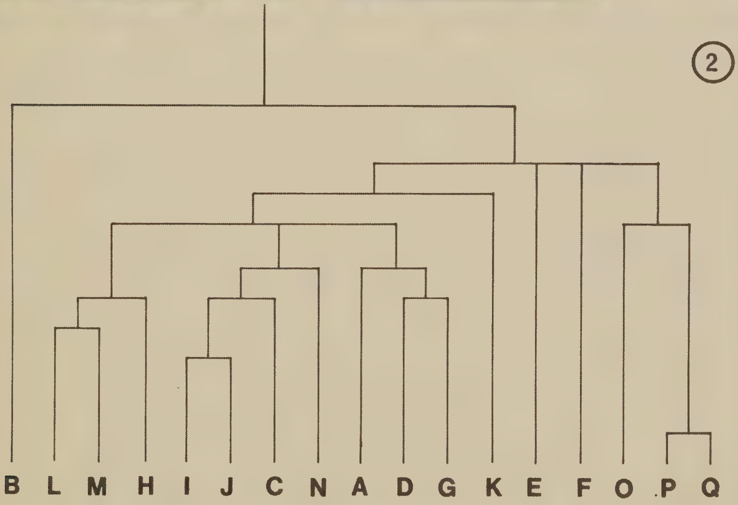
Unknown substances : unknown-7 (24) and Lcm-1* (25).

* These unknown substances were first described by Brodo (1984).

The standardized chromatographic data for these compounds are listed in Table 1 and the distribution of these substances among the chemical races of *L. epibryon* s. amp. is shown in Table 2. While races A-N represent the Southern Hemisphere specimens (*L. broccha*), races O, P and Q were observed only in Northern Hemisphere specimens (*L. epibryon*). The chemical diversity of this species complex is quite unexpected: more substances are found in this species complex than in the whole of *Lecanora* s. str. in North America (Brodo 1984).

Throughout their distribution, the Southern Hemisphere specimens were morphologically and anatomically comparable (Figures 1A, 1B) with one another and could not be distinguished without chemical analysis. There was no apparent correlation of chemistry with geographic distribution. For example, although the races C, K-N all

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B L M H I J C N A D G K E F O P Q

Figure 1 : *Lecanora broccha,* habit ; A, Lectotype of *L. broccha* (BM); B, Isotype of *L. parmelina* (BM). Scale = 1 mm.
Figure 2 : Phenogram of the chemical strains in the *L. epibryon* group.

Table 1. Standardized Chromatographic Data for *Lecanora* Metabolites

Standard R_F values (x 100) were determined in solvent systems: (A) toluene / dioxane / acetic acid (180:45:5); (B) hexane / diethyl ether / formic acid (130:80:20); (B*) hexane / *t*-butyl methyl ether / formic acid (140:72:18); (C) toluene / acetic acid (170:30); (E) ethyl acetate / cyclohexane (25:75); (G) toluene / ethyl acetate / formic acid (139:83:8). Standard R_T values in h.p.l.c. are given in minutes.

Compound R_F	(A)	(B)	(B*)	(C)	(E)	(G)	R_T
Atranorin (**1**)	75	78	73	79	57	--	7.37
Chloroatranorin (**2**)	74	79	73	81	30	--	8.43
Barbatic Acid (**3**)	44	69	67	52	--	--	7.52
4-*O*-Demethylbarbatic Acid (**4**)	39	60	54	36	--	--	4.82
Methyl barbatate (**5**)	77	--	73	86	--	--	10.04
Connorstictic Acid (**6**)	11	11	11	3	--	26	3.23
Constictic Acid (**7**)	7	3	1	2	--	9	3.15
Cryptostictic Acid (**8**)	14	14	10	10	--	27	3.38
Hypoprotocetraric Acid (**9**)	25	43	37	22	--	48	4.75
Menegazziaic Acid (**10**)	19	--	14	12	--	36	3.59
Norstictic Acid (**11**)	40	29	32	30	--	57	3.91
Stictic Acid (**12**)	32	9	9	18	--	34	3.60
Lecanoric Acid (**13**)	28	44	44	22	--	56	4.00
Xanthone x-1 (**14**)	--	--	--	65	12	--	8.60
Xanthone x-2 (**15**)	--	--	--	60	6	--	8.49
Thiophanic Acid (**16**)	55	56	52	49	--	--	8.20
Xanthone x-4 (**17**)	--	--	--	38	--	--	6.10
Isoarthothelin (**18**)	45	--	44	36	6	--	6.61
Lgr-1* (**19**)	58	63	--	55	--	--	--
Lgr-2* (**20**)	50	44	--	39	--	--	--
Zeorin (**21**)	52	42	43	43	19	50	--
Ursolic Acid (**22**)	52	50	54	49	25	--	--
Methyl β-orsellinate (**23**)	64	70	--	55	--	--	4.12
Unknown-7 (**24**)	--	--	--	7	--	--	--
Lcm-1* (**25**)	63	25	--	39	--	--	--

Table 2. Distribution of Lichen Acids in the *Lecanora epibryon* Complex

(# = major substance; + = minor substance; - = absent)

Race: Substance	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	#	-	-	#	#	-	#	#	#	#	+	+	#	#	-	#	#
2	#	-	-	#	#	-	#	#	#	#	+	+	#	#	-	#	#
3	#	-	-	-	-	#	+	-	-	-	#	-	-	-	-	-	-
4	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-
5	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
7	+	+	+	+	-	-	-	-	+	+	-	-	-	+	-	-	-
8	-	+	+	-	-	-	-	-	+	+	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	#	-	-
10	-	+	+	-	-	-	-	-	+	+	-	-	-	-	-	-	-
11	-	+	+	-	-	-	-	-	+	+	-	-	-	#	-	-	-
12	+	#	#	+	-	-	+	-	#	+	-	-	-	+	-	-	-
13	-	-	-	-	-	-	-	-	-	-	#	-	-	-	-	-	-
14	-	#	-	-	-	+	#	#	-	-	-	#	#	-	-	-	-
15	+	#	#	#	-	+	#	#	+	-	+	#	#	-	-	-	-
16	-	-	-	-	+	-	+	-	-	-	+	#	-	-	-	-	-
17	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
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20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
22	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-
23	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
24	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	-
25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-

occurred in Tasmania, they were morphologically variable as well as being chemically distinguishable - but not more dissimilar from one another than from other specimens collected in Australasia or South America. A phenogram comparing the chemical - races using all the chemical data and their distribution - did not show any clear patterns (Figure 2). Table 3 illustrates the distribution of lichen products within the chemical races according to the major classes of substances. We again could not find any correlation of these classes with geographic distribution (Table 4).

The number of chemical races within this species complex is quite unusual within the lichenized Ascomycetes. Although Filson (1981) reported 50 different chemical races for *Cladia aggregata* (Sw.) Nyl., the species concept in this group has since changed with two additional taxa segregated from *C. aggregata* s. lat. (Kantvilas & Elix 1987), so that the chemical variation in *C. aggregata* s. str. now is less dramatic.

Table 3. Classes of Lichen Acids in the *Lecanora epibryon* Complex

(# = major substance; + = minor substance; - = absent)

Race:	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Substance																	
Orcinol Depsides	-	-	-	-	-	-	-	-	-	-	#	-	-	-	-	-	-
ß-Orcinol Depsides	#	-	-	#	#	#	#	#	#	#	#	+	#	#	-	#	#
ß-Orcinol Depsidones	+	#	#	+	-	-	+	-	#	+	-	-	-	-	#	-	-
Xanthones	+	#	#	#	+	+	#	#	+	-	+	#	#	-	-	-	-
Triterpenoids	-	-	-	-	-	-	-	-	-	-	-	+	+	-	-	+	+

Table 4. Distribution of Chemical Races in the *Lecanora epibryon* Complex

Race:	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Location																	
Australia	-	+	+	-	-	-	-	+	+	-	-	-	-	-	-	-	-
Kerguelen	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
New Zealand	+	+	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-
Northern Hemisphere	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+
South America	-	-	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-
Tasmania	-	-	+	-	-	-	-	-	-	-	+	+	+	+	-	-	-

Probably further studies in the *L. epibryon* complex will show that it too is heterogeneous. Possibly some of the chemical races may be adapted to different habitats or will show other minute, as yet undiscovered, differences which may enable the delimitation of some populations at the species level. However at this time we are unable to delimit any natural groups among the chemical races or draw any taxonomic conclusions from our chemical survey - and it appears highly likely that future investigations will elucidate further chemical races within the species complex.

Given the chemical and morphological uniformity of *L. epibryon* in the Northern Hemisphere versus the chemical and morphological diversity of *L. broccha* in the Southern hemisphere, for the interim we propose to maintain the distinction of these two species. Possibly this is an unnatural distinction which will be superceded by further studies. Certainly some of the Southern Hemisphere races are chemically more closely related to *L. epibryon* s. str. than to other races of *L. broccha.*

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A MONOGRAPH OF THE LICHEN GENUS KAROOWIA HALE (ASCOMYCOTINA: PARMELIACEAE)

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Abstract. A new lichen genus, *Karoowia* Hale, is described. It is related to *Xanthoparmelia* but differentiated by the subcrustose, marginally effigurate-lobate growth form, presence of rhizoid-like structures on the lower surface, and relatively long, cylindrical conidia. The 16 species presently recognized occur chiefly in South Africa. *Karoowia microscopica* Hale, *K. protocetrarica* Hale, *K. salazinica* Hale, and *K. subchalybaeizans* Hale are described as new. New combinations are made for these species: *K. adhaerens* (Nyl.) Hale, *K. adligans* (Brusse) Hale, *K. arquata* (Brusse) Hale, *K. ganymedea* (Brusse) Hale, *K. insipida* (Brusse) Hale, *K. leptoplaca* (Brusse) Hale, *K. perspersa* (Stizenb.) Hale, *K. ralla* (Brusse) Hale, *K.saxeti* (Stizenb.) Hale, *K. scitula* (Brusse) Hale, *K. spissa* (Brusse) Hale, and *K. squamatica* (Brusse) Hale.

Introduction

While completing a monograph of *Xanthoparmelia* (Ascomycotina: Parmeliaceae), I found a small group of 16 species, occurring almost exclusively in South Africa, which did not fit well in this otherwise quite homogeneous genus. They are very tightly adnate and subcrustose in appearance, often with a strongly areolate-cracked center and effigurate-lobate thallus margins, not unlike *Dimelaena oreina* (Ach.) Massal., *Lecanora (Protoparmelia) muralis* (Schreber) Rabenh., and other marginally lobate crustose lichens. More significantly, they lack rhizines and either have a nearly bare lower surface or one covered with rhizoid-like attachment organs which have been misinterpreted as poorly developed rhizines.

In many of the species the apothecia are immersed to flush and aspicilioid, remaining that way at maturity or becoming emergent to sessile and typically parmelioid with a distinct lecanorine rim. The conidia are cylindrical and rather long, 6 – 12 μm, in contrast to the short bifusiform conidia of *Xanthoparmelia*. On the other hand, the positive (I+) lichenin reaction (R. Common, personal communication), colorless, subspherical to ellipsoidal spores, and the presence of a pored epicortex are unmistakably parmelioid.

The group has been recognized as unique by Brusse (1986), who refers to them as "effigurate-crustose Xanthoparmelias" and has already described 8 of the 16 species presently known. He could not justify placing them in *Protoparmelia* Choisy or *Protoparmeliopsis* Choisy because of differences in ascal structure. I believe that these species, although obviously closely related to *Xanthoparmelia*, represent a new genus, *Karoowia*, in the Parmeliaceae.

Thallus aspect and adnation:—At first glance, specimens of *Karoowia* appear to be small, very tightly adnate *Xanthoparmeliae*. However, it is impossible to remove them with a knife and even in the laboratory it is extremely difficult to scrape off thallus fragments for extraction with acetone prior to doing TLC analysis. None of the 16 species has lobes more than about 1 mm wide and most are in the range of 0.2 – 0.8 mm. The smallest species of *Xanthoparmelia* with lobes in this range, such as *X. keralensis* Hale or *X. mougeotii* (Schaerer) Hale, can still be separated from the rock with a razor blade or dissecting needle to reveal a lower surface covered with normal cylindrical rhizines.

The lobes are flat and very tightly appressed in *K. adligans*, *K. ganymedea*, *K. insipida*, *K. leptoplaca*, *K. protocetrarica*, and *K. ralla*. The thallus center in these species is also strongly areolate-cracked. The remaining species have more or less convex, less tightly appressed lobes. In addition the thallus center is either less strongly areolate, areolate-bullate, or simply lobate. The thallus, while very thin (100–300 μm), has a normal internal structure with an upper cortex, algal layer, medulla, and lower cortex (Figs. 1, 5, 6).

Upper surface:—The thallus surface of all species is continuous and emaculate. Many produce white pruina (Fig. 2). The fine structure with SEM is variable. All species appear to have a pored epicortex (Fig. 3), identical with that in other parmelioid genera, including *Xanthoparmelia*. A few specimens of some of the species, in particular *K. perspersa*, have a surface composed of exposed truncated tips of palisade-oriented cortical cells (Fig. 4). Other species sometimes showing this trait include *K. ganymedea*, *K. leptoplaca*, *K. ralla*, and *K. scitula*. In these cases the epicortex has apparently eroded away, a condition which may be observed even in *Xanthoparmelia colorata* (Gyel.) Hale and other *Xanthoparmelia* species adapted to very arid habitats.

Lower surface:—When one tries to examine the lower surface of a *Karoowia* species, the thallus is so tightly appressed to the rock that it is difficult to get any idea of its structure. Using a razor blade and cutting through the thallus to the rock surface or teasing up an occasional free lobe tip under 10–20X magnification, one can see a fine spongy or felty layer but no true cylindrical rhizines. Viewed with a scanning electron microscope, one observes a fragile, thin but distinct lower cortex more or less covered with separate, tomentum-like rhizoids (Figs. 7, 8, 9) or irregular, flattened, lamella-like, loose aggregations of rhizoids (Figs. 10–12), similar in fact to the attachment structures found in the subcrustose genus *Dimelaena*. As far as I know, this structure is unique for the Parmeliaceae, and is being reported here for the first time.

Seven species are black below: *K. adhaerens*, *K. arquata*, *K. adligans*, *K. ganymedea*, *K. leptoplaca*, *K. microscopica*, and *K. saxeti*. The remaining species are pale brown.

Vegetative structures:—Thirteen of the species produce no isidia, soredia or other vegetative propagules. Two, *K. microscopica* and *K. saxeti*, are isidiate, and one, *K. ganymedea*, is pustulate-sorediate.

Reproductive structures:—Brusse (1986) concluded that the internal structure of apothecia in *Karoowia* is consistent with that of *Parmelia* s.l. The main differences among the 16 species lie in the degree of immergence of the apothecia. In one group, including *K. leptoplaca* (*K. adligans* (Fig. 14), *K. arquata*, *K. insipida*, and *K. protocetrarica*), the apothecia are immersed and the disc is flush with the thallus surface, superficially similar to the aspiciloid apothecia of *Aspicilia*. A thalline rim may or may not be present, but the subhymenium is always underlain by algae. These apothecia reach 0.2–0.5 mm in diameter.

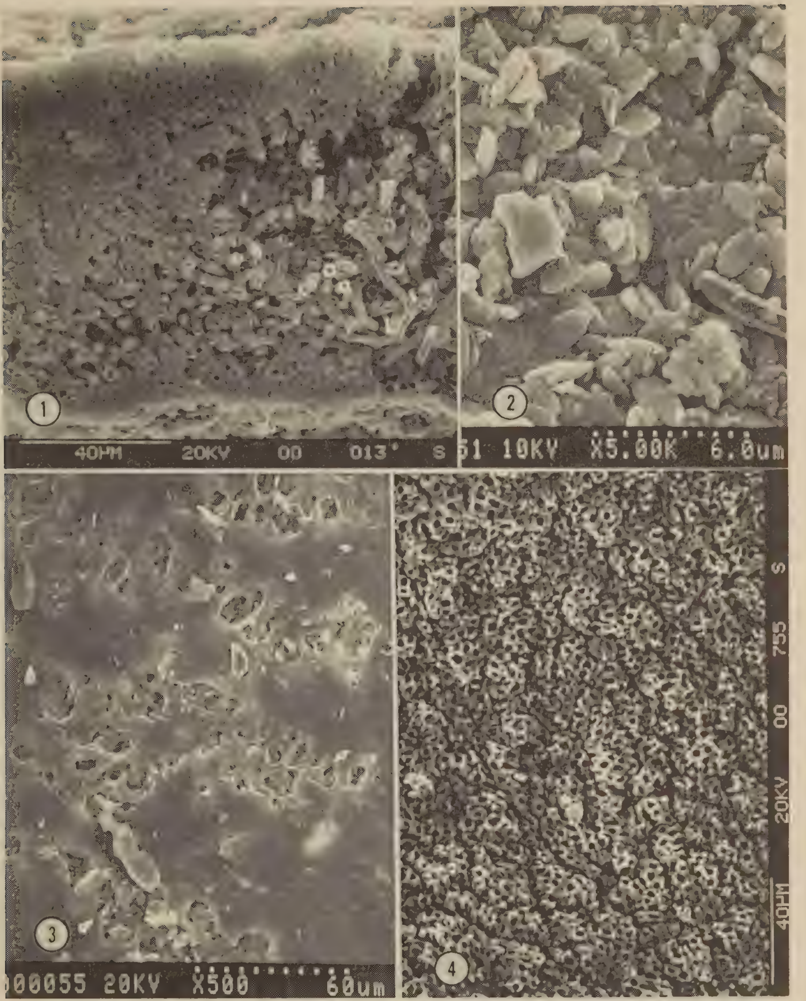
A second group, including *K. adhaerens*, *K. ralla* (Fig. 22), *K. salazinica*, *K. saxeti*, *K. scitula*, and *K. spissa*, also has aspicilioid apothecia in the early stages but they soon emerge to become sessile with a distinct thalline rim. These apothecia are up to 1 mm in diameter.

The third group with two species, *K. perspersa* (Fig. 20) and *K. subchalybaeizans*, has emergent apothecia from the earliest stages. At maturity they are sessile to adnate and up to 5 mm in diameter, as in typical, tightly adnate *Xanthoparmelia* species.

Pycnidia are produced in nearly all species, appearing as black dots immersed in the thallus. Conidia are relatively long (6–12 μm) and cylindrical. In *Xanthoparmelia* the conidia are bifusiform (or only rarely cylindrical) and 5–8 μm long.

Chemistry:—Considering the small number of species involved, *Karoowia* has a rich chemistry, largely paralleling that of *Xanthoparmelia*. The K+ depsidones are well represented by norstictic acid, salazinic acid, stictic acid, and the chalybaeizans unknown. Echinocarpic acid, a presumed depsidone of unknown structure, is also rarely present. K− depsidones and *para*-depsides include norlobaridone, protocetraric acid, psoromic acid, squamatic acid, and hypoprotocetraric acid. The depsides evernic and lecanoric acids are also found in a few species.

Ecology and habitats:—The species of *Karoowia* occur in exposed or extremely arid habitats in the Great Karoo and Namaqualand in Cape Province as well as in semi-arid to relatively moist areas of Natal, Transvaal, and Lesotho on a variety of rocks such as dolerite, sandstone, and granite. In the arid karoo where rainfall is less than 100 mm/year *K. leptoplaca* is often the last surviving foliose lichen, taking over from the hardiest species of *Xanthoparmelia*. I have not found any *Karoowia* species in areas with less than 50 mm rainfall.


1
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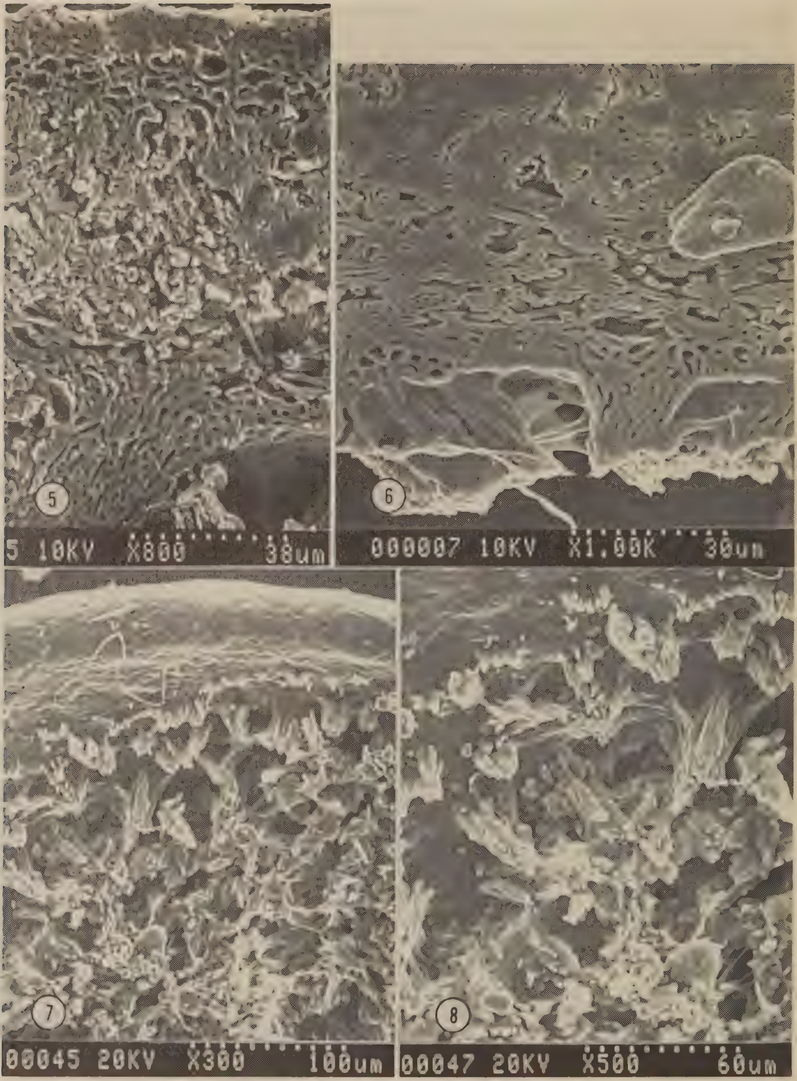
Figures 1–4. Cross section and surface structure of *Karoowia*: 1, vertical cross section of *K. insipida* (*Hale* 74895); 2, pruina on surface of *K. perspersa* (*Hale* 79238); 3, epicorticate surface of *K. adhaerens* (Hale 78158); 4, abraded surface of *K. perspersa* showing palisade layer without overlying epicortex (*Hale* 73060).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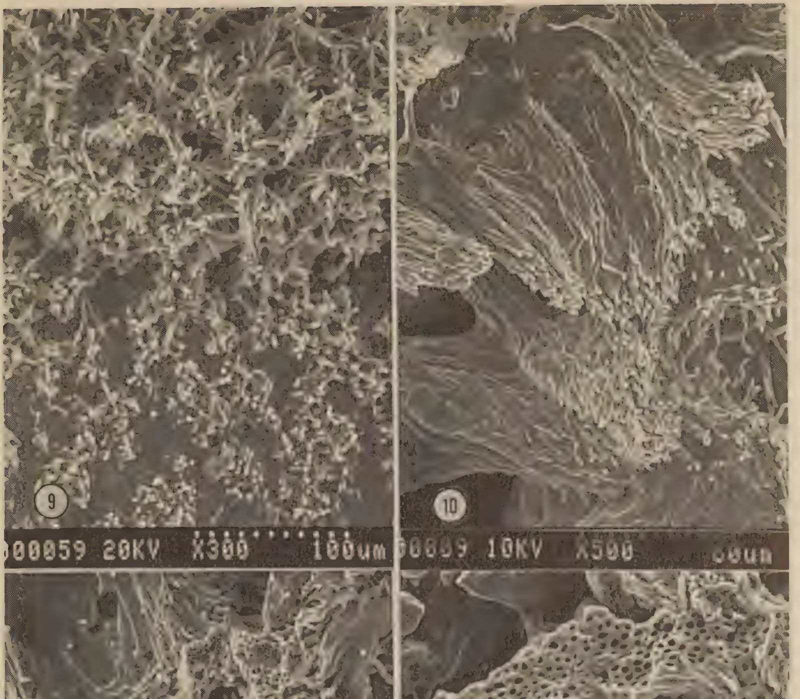
5 10KV X800 38um
6
000007 10KV X1.00K 30um
7
00045 20KV X300 100um
8
00047 20KV X500 60um

Figures 5–8. Lower surface features of *Karoowia*: 5, vertical cross section of *K. spissa* to show lower cortex and origin of rhizoidal lamellae (*Hale* 74889); 6, vertical cross section of *K. saxeti* to show lower cortex and origin of rhizoidal lamellae (*Hale* 79251); 7, oblique view of lower surface of *K. adhaerens* showing mixture of lamellae and rhizoids (*Hale* 71059); 8, close-up of fig. 7.


9
00059 20KV X300 100um
10
10KV X500
11
0007 10KV X500 60um
12
000032 10KV X1.00K

Figures 9 – 12. Lower surface features of *Karoowia*: 9, dense rhizoidal layer on *K. adhaerens* (*Hale* 78128); 10, clumped rhizoids as lamellae form in *K. adhaerens* (*Hale* 71021); 11, mixed rhizoids and lamellae in *K. subchalybaeizans* (*Hale* 77655); 12, cross section of lamellae of *K. adhaerens* (*Hale* 73809).

Karoowia Hale, gen. nov.

Thallus arcte adnatus, margine lobatus, centrum versus subcrustaceo-areolatus, lobis sublinearibus, 0.2–1.2 mm latis, superne continuus, emaculatus, epicorticatus, saepe albo-pruinosus, subtus rhizoideis vel lamellis instructus. Conidia cylindrica. Apothecia immersa, saepe aspicilioidea, vel emergentia, sporis incoloribus, simplicibus.

Type species: *Parmelia adhaerens* Nyl.

Key to the Species of *Karoowia*

1. Thallus coarsely sorediate . . . *K. ganymedea*
1. Thallus not sorediate . . . 2
  2. Thallus isidiate . . . 3
  2. Thallus not isidiate . . . 4
3. Lobes broad, to 1 mm wide; medulla K+ yellow (stictic acid). . . *K. saxeti*
3. Lobes narrower, less than 0.6 mm wide; medulla K− (norlobaridone) . . . *K. microscopica*
  4. Lower surface black . . . 5
  4. Lower surface tan to brown . . . 8
5. Apothecia persistently aspicilioid; salazinic acid present . . . *K. leptoplaca*
5. Apothecia aspicilioid to sessile; salazinic acid lacking. . . 6
  6. Psoromic acid present . . . *K. arquata*
  6. Stictic acid present . . . 7
7. Lobes flat and appressed; apothecia persistently aspicilioid . . . *K. adligans*
7. Lobes flattish to convex; apothecia sessile at maturity . . . *K. adhaerens*
  8. Medulla P+ yellow to orange-red . . . 9
  8. Medulla P− . . . 11
9. Lobes flat and appressed; apothecia persistently aspicilioid; protocetraric acid present . . . *K. protocetrarica*
9. Lobes flattish to convex; apothecia sessile; salazinic acid present . . . 10
  10. Thallus areolate-cracked at the center; chalybaeizans unknown lacking . . . *K. salazinica*
  10. Thallus lobate at the center; chalybaeizans unknown present . . . *K. subchalybaeizans*
11. Medulla C+ red (lecanoric acid (major)) . . . *K. scitula*
11. Medulla C− (lecanoric acid if present minor) . . . 12
  12. Squamatic acid present . . . *K. squamatica*
  12. Squamatic acid lacking . . . 13
13. Norlobaridone present . . . *K. ralla*
13. Norlobaridone lacking . . . 14
  14. Hypoprotocetraric acid present; apothecia large, adnate . . . *K. perspersa*
  14. Hypoprotocetraric acid lacking; apothecia small, initially aspicilioid . . . 15
15. Lobes flat and appressed; evernic acid present (major) . . . *K. insipida*
15. Lobes convex; evernic and lecanoric acids present . . . *K. spissa*

1. **Karoowia adhaerens** (Nyl.) Hale, comb. nov.

Parmelia adhaerens Nyl. in Crombie, Journ. Bot. Brit. For. 14:19.1876. Type collection: Table Mountain, Cape of Good Hope, Cape Province, South Africa, *Eaton s.n.* (BM, lectotype; H-Nyl, no. 34823, isolectotype).

Parmelia interrupta Stizenb., Ber. Tätig. St. Gall. Naturw. Gesell. 1888–1889:154. 1890. Type collection: Ceres, Bokkeveld Mountains, Cape Province, South Africa, *MacOwan s.n.* (ZT, lectotype).

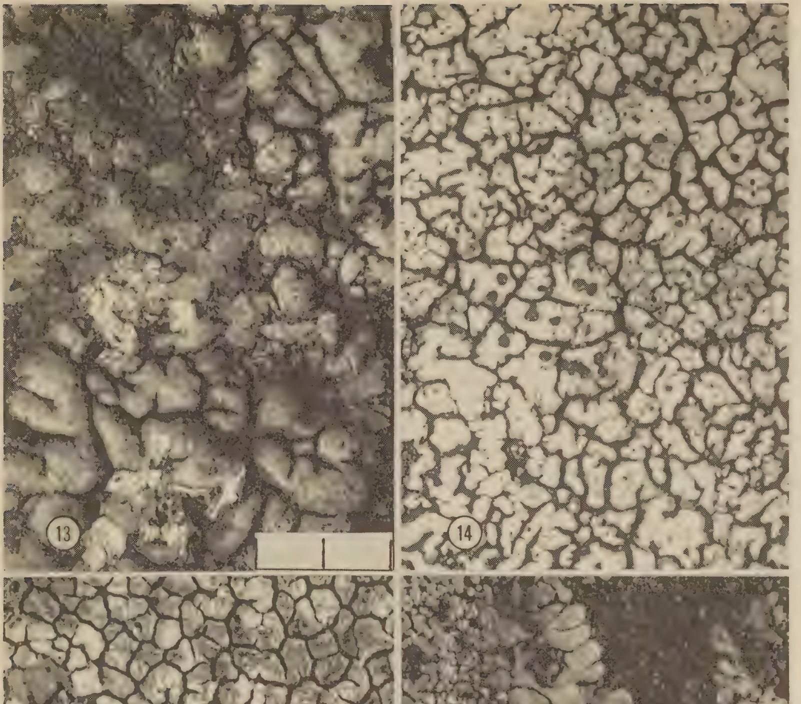
Squamaria interrupta (Stizenb.) Gyelnik, Ann. Hist.-Nat. Mus. Nat. Hungarici, 29:36. 1935.

Xanthoparmelia adhaerens (Nyl.) Hale, Phytol. 28:486. 1974.

Xanthoparmelia interrupta (Stizenb.) Krog & Swinscow, Lichenologist 19:427. 1987.

Thallus (Fig. 13) saxicolous, subcrustose, the center areolate to more or less bullate-areolate with marginally effigurate lobes, 3–6 cm broad, yellowish green or darkening; lobes sublinear, 0.3–0.8 mm wide, convex, rather short, little branched, contiguous, usually black-rimmed; upper surface continuous, emaculate, shiny to dull, epruinose, soredia and isidia lacking; lower surface black, nearly bare to spongy with rhizoids and lamellae. Pycnidia common; conidia cylindrical, 0.5 × 7–9 μm. Apothecia initially flush, sessile to adnate at maturity, 0.5–1 mm in diameter; spores 5–6 × 9–10 μm.

Chemistry: Stictic, constictic, peristictic, hypostictic (±trace), hypoconstictic (±trace),



Figures 13 – 16. Species of *Karoowia*: 13, *K. adhaerens* (lectotype in BM); 14, *K. adligans* (*Hale*, 75912); 15, *K arquata* (isotype in US); 16, *K. ganymedea* (*Hale* 76104). Scale = 2 mm (in Fig. 13).

hyposalazinic (±trace), and usnic acids.

Before the true nature of the lower surface was understood, this species was thought to be a *Xanthoparmelia* and to occur not only in southern Africa but also in Australia (Elix, et al., 1986). The reported Australian specimens have been re-identified as *X. xanthomelaena* (Müll. Arg.) Nash & Elix; *K. adhaerens* does not occur in Australia (Hale, 1989).

While the hypostictic acid complex is often produced with stictic acid, it is not constant (cf. Krog & Swinscow, 1987). One other stictic acid-containing species in the genus, *K. saxeti*, is isidiate and also differs in having a more lobate, nonareolate center and pale-rimmed lobes. Another nonisidiate species, *K. adligans*, has the same chemistry but persistently aspicilioid apothecia and a tightly appressed thallus.

This is one of the more commonly collected species in the genus, occurring on sandstone, generally in the mountains from the Cape of Good Hope through southern Cape Province, Natal, the Drakensberg escarpment in Transvaal, and the Soutpansberg mountains (Map 1).

Representative specimens examined (all in US). South Africa. Venda: Tschikadeni Mine area, Grid 2231 AC, *Hale* 79116. Transvaal: Long Tom Pass, Grid 2430 BA, *Hale* 73913; Mt. Sheba Nature Reserve, Grid 2430 DC, *Hale* 76109. Natal: 14 km S of Nkandla, Grid 2831 CA, *Hale* 76378. Cape Province: Sir Lowry's Pass, Grid 3418 BD, *Hale* 78141; 21 km S of Worcester, Grid 3319 CB, *Hale* 78212; Uniondalespoort, Grid 3323 CA, *Hale* 73809. Swaziland: Mbabane Nature Reserve, Grid 2631 AA, *Hale* 79035.

2. **Karoowia adligans** (Brusse) Hale, comb. nov.

Parmelia adligans Brusse, Mycotaxon 31:533. 1988. Type collection: Clearwater Falls, Blydesrivier Nature Reserve, Transvaal, South Africa, *Brusse* 4452 (PRE, holotype (not seen); BM, COLO, LD, isotypes).

Thallus (Fig. 14) saxicolous, subcrustose and very tightly adnate, the center strongly aeolate-cracked, margins lobate, 3-6 cm broad, light yellowish green; lobes appressed, flat and splaying out at the tips, 0.2–0.6 mm wide, pale to dark rimmed, contiguous; upper surface continuous, emaculate, dull, coarsely pruinose at the tips with age, soredia and isidia lacking; lower surface black, spongy, consisting of rhizoids and weakly developed lamellae. Pycnidia common; conidia cylindrical, 0.5 × 5–7 μm. Apothecia aspicilioid, 0.2–0.3 mm in diameter, the disk dark brown; spores ellipsoidal, 5–6 × 10–14 μm.

Chemistry: Stictic, constictic, norstictic (±trace), hypostictic (±trace), hyposalazinic (±trace), and usnic acids, atranorin (±trace).

Illustration: Brusse, *Mycotaxon* 31:553. 1988 (Fig. 4).

This species, largely confined to Transvaal and adjacent northern Cape Province (Map 2), resembles salazinic acid-containing *K. leptoplaca* very closely in apothecial morphology and lobe configuration. Formerly misidentified as *K. adhaerens*, it differs from that species in the tighter adnation and aspicilioid apothecia.

Representative specimens examined (all in US). South Africa. Transvaal: 10 km NW of Rustenberg, Grid 2527 CA, *Hale* 80868; Long Tom Pass, Grid 2430 BA, *Hale* 73910; 2 km S of Lejuma Summit, Soutpansberg Mountains, Grid 2329 AB, *Hale* 73914. Cape Province: 5.5 km W of Olifantshoek, Grid 2722 DC, *Hale* 79480.

3. **Karoowia arquata** (Brusse) Hale, comb. nov.

Parmelia arquata Brusse, Mycotaxon 31:535. 1988. Type collection: Linksfield Ridge, Johannesburg, Transvaal, South Africa, Grid 2628 AA, *Brusse* 1126 (PRE, holotype (not seen); ANUC, BM, COLO, LD, MEL, US, isotypes).

Thallus (Fig. 15) saxicolous, subcrustose, areolate at the center with effigurate marginal lobes, to 4 cm broad, yellowish green; lobes sublinear, 0.2–1 mm wide, contiguous; upper surface continuous, emaculate, becoming pruinose at the tips; lower surface black with a spongy layer of rhizoids. Pycnidia common; conidia cylindrical, 0.5 × 5–8.5 μm. Apothecia immersed and aspicilioid, to 0.8 mm in diameter; spores ellipsoidal, 4–7 × 8–11 μm.

Chemistry: Psoromic and usnic acids, atranorin.

Illustration: Brusse, *Mycotaxon* 31:553. 1988 (Fig. 5).

This species is known only from the type locality in Johannesburg. It is a member of the *K. leptoplaca* group.

4. **Karoowia ganymedea** (Brusse) Hale, comb. nov.

Parmelia ganymedea Brusse, Mycotaxon 31:536. 1988. Type collection: Linksfield Ridge, Transvaal, South Africa, *Brusse* 5089 (PRE, holotype (not seen); BM, COLO, LD, US, isotypes).

Thallus (Fig. 16) saxicolous, subcrustose, rimose-areolate at the center with small effigurate marginal lobes, 1–8 cm broad, dark yellowish green; lobes sublinear, 0.3–0.5 mm wide, tightly appressed, flat, sparsely dichotomously branched, contiguous to subimbricate, becoming densely sorediate-isidiate to coarsely pustulate-sorediate along the margins; upper surface continuous, emaculate, lightly pruinose; lower surface black with a black spongy layer of rhizoids. Pycnidia and apothecia lacking.

Chemistry: Evernic and usnic acids.

Illustration: Brusse, *Mycotaxon* 31:553. 1988 (Fig. 6).

This is the only species in the genus with marginal isidiate soredia. It occurs on sandstones, mostly in Transvaal with one locality in eastern Cape Province (Map 3). It does not seem to be related to nonsorediate, evernic acid-containing *K. insipida*, a larger lichen with a pale lower surface.

Specimens examined (all in US). South Africa. Transvaal: Lejuma Summit, Soutpansberg Mountains, Grid 2329 AB, *Hale* 72967, 72968; Mt. Sheba Nature Reserve, Grid 2430 DC, *Hale* 76104; Long Tom Pass, Grid 2430 BA, *Hale* 72966, 72969. Cape Province: 18.5 km WNW of Molteno, Grid 3126 AC, *Hale* 80535.

5. **Karoowia insipida** (Brusse) Hale, comb. nov.

Parmelia insipida Brusse, Mycotaxon 27:238. 1986. Type collection: Lootsberg Pass between Graaff-Reinet and Middelburg, Cape Province, South Africa, Grid 3124 DD, *Brusse* 4692 (PRE, holotype (not seen); BM, LD, US, isotypes).

Thallus (Fig. 17) saxicolous, subcrustose, strongly areolate-cracked at the center with lobate margins, 2–9 cm broad, pale yellowish green; lobes sublinear, 0.2–0.6 mm wide, flat and tightly appressed, rather short and irregularly branched, contiguous; upper surface continuous, emaculate, shiny to dull and white pruinose towards the tips, transversely cracked with age, soredia and isidia lacking; lower surface pale brown with a pale spongy layer of rhizoids and lamellae. Pycnidia common; conidia cylindrical, 0.5 × 6–12 μm. Apothecia at first aspicilioid, 0.2–0.7 mm in diameter, only in part slightly emergent, becoming sessile at maturity, the disk dark brown; spores subspherical to ellipsoidal, 5–8 × 7–10 μm.

Chemistry: Evernic, lecanoric (±trace), and usnic acids.

Illustration: Brusse, *Mycotaxon* 27:243. 1986 (Fig. 4).

Externally this species is very similar to *K. adligans* and *K. leptoplaca* because of the aspicilioid apothecia and flat, appressed lobes. Lecanoric acid, if detectable, is in very low concentration. Another evernic acid-containing species, *K. spissa*, has significant amounts of lecanoric acid, as well as a thicker thallus and emergent apothecia. *Karoowia insipida* occurs on sandstones from eastern Orange Free State and Natal westward into Cape Province (Map 4).

Representative specimens examined (all in US). South Africa. Orange Free State: Golden Gate National Park, Grid 2828 BC, *Hale* 74895. Cape Province: Moltenopas, Grid 3222 BA, *Hale* 73806; Naudesbergpas, Grid 3124 DD, *Hale* 75716. Transkei: 16 km NW of Matatiele, Grid 3028 BA, *Hale* 81296. Lesotho: Sani Pass, Grid 2929 CB, *Hale* 74888; 8.3 km ENE of Ramats'Eliso's Gate, Grid 3028 BB, *Hale* 81064.

6. **Karoowia leptoplaca** (Brusse) Hale, comb. nov.

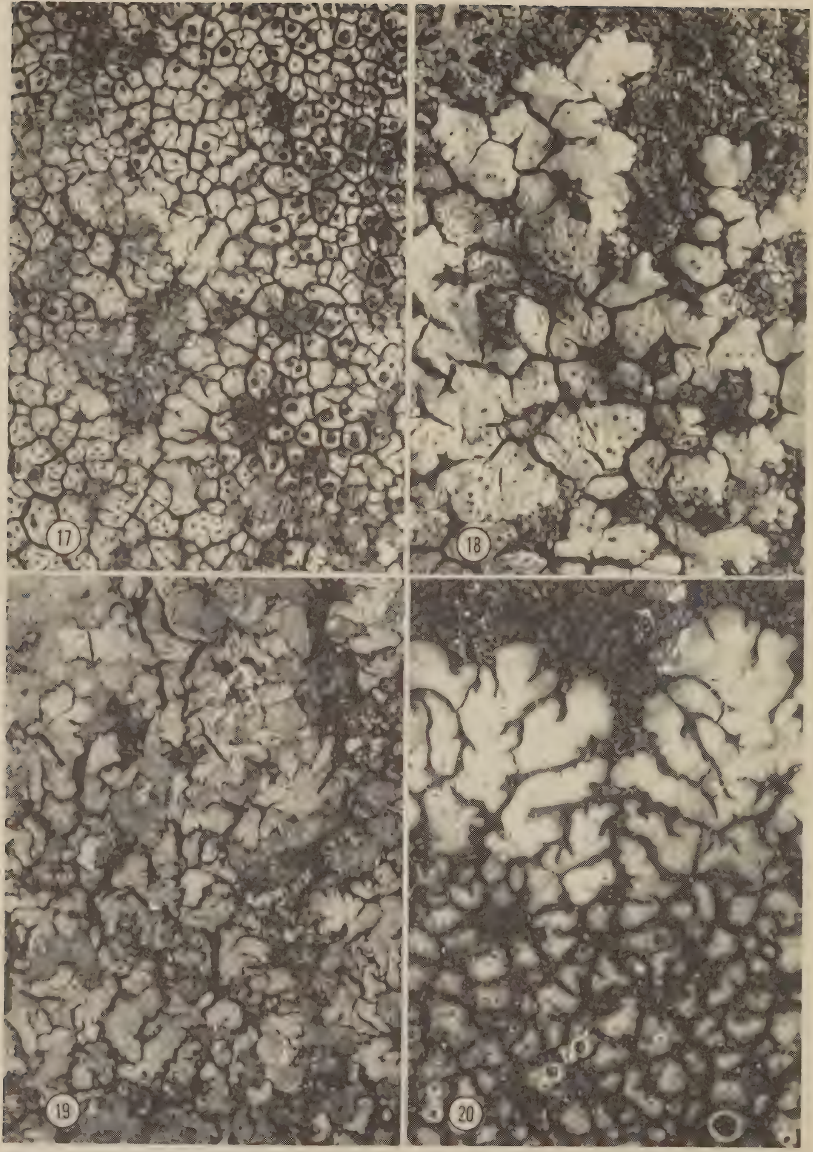
Lecanora leptoplaca Zahlbr., Ann. Crypt. Exot. 5:249. 1932. Type collection: Lainsburg, Grosse Karroo, Cape Province, South Africa, *Brunnthaler* s.n. (WU, lectotype). Not *L. leptoplaca* Nyl.

Parmelia leptoplaca [Zahlbr.] Brusse, Mycotaxon 27:242. 1986.

Thallus (Fig. 18) saxicolous, subcrustose, more or less dispersed or continuous and strongly areolate-cracked at the center, 2–10 cm broad, bright greenish yellow; lobes subirregular, 0.3–0.7 mm wide, flat and tightly appressed, irregularly branched, contiguous; upper surface continuous, emaculate, dull, pruinose at the tips, transversely cracked, soredia and isidia lacking; lower surface black, nearly bare to sparsely rhizoidal or with a weakly developed lamellar layer. Pycnidia common; conidia cylindrical, 0.5 × 6–8 μm. Apothecia aspicilioid to barely emergent, 0.3–0.5 mm in diameter, the disk dark brown with a pruinose rim; spores 6 × 9 μm.

Chemistry: Salazinic, consalazinic, and usnic acids, atranorin (±).

This is a common species on basaltic rocks, more rarely sandstone, on the southern and western fringes of the Great Karoo (Map 5). It is in fact often the last parmeliaceous lichen found as one



Figures 17–20. Species of *Karoowia*: 17, *K. insipida* (isotype in US); 18, *K. leptoplaca* (*Hale* 73808); 19, *K. microscopica* (holotype in US); 20, *K. perspersa* (lectotype in ZT). See Fig. 13 for scale.

goes north into the very arid central part of the Great Karoo. Morphologically similar *K. adligans* (stictic acid) and *K. insipida* (evernic acid) have different distributions in South Africa. Since Zahlbruckner's epithet is a homonym, Brusse becomes the author of the species in the genus *Parmelia*.

Representative specimens examined (all in US). South Africa. Cape Province: 28 km NW of Graaff-Reinet, Grid 3224 AB, *Hale* 80511; 22 km NE of Prince Albert, Grid 3322 AB, *Hale* 75906; Bloukrans Pass, Grid 3119 DB, *Hale* 79845; Winterhoek Pass, Grid 3124 BD, *Hale* 80524.

7. **Karoowia microscopica** Hale, sp. nov.

Thallus subcrustaceus, 2–6 cm latus, lobis sublinearibus, 0.3–0.6 mm latis, superne continuus, sparse isidiatus, subtus niger, rhizoideis instructus.

Thallus (Fig. 19) saxicolous, subcrustose, dispersed and lobate to weakly areolate at the center, 2–6 cm broad, dull yellowish green but lighter at the tips; lobes sublinear, 0.3–0.6 mm wide, short, separate to contiguous, black rimmed; upper surface continuous, emaculate, shiny to dull, transversely cracked, sparsely isidiate, the isidia cylindrical or subglobose (but not erumpent), black tipped, 0.05–0.09 mm in diameter, to 0.1 mm high; lower surface black, sparsely rhizoidal or with poorly developed lamellae. Pycnidia and apothecia lacking.

Chemistry: Norlobaridone, echinocarpic (trace), and usnic acid (det. J. A. Elix).

Type: On sandstone outcrop in grassy veld, trail to Langalibalele Cave, Bushman's Nek, Natal, South Africa, Grid 2929 BC, *Hale* 76636, 3 Oct. 1986 (US, holotype; PRE, isotype).

The only other isidiate species in the genus, *K. saxeti*, contains stictic acid and is much larger. *Karoowia microscopica* is a rarely collected lichen, known from sandstones in north-central Transvaal and in the Drakensberg foothills in Natal (Map 6). It seems to have no relation with the other norlobaridone-containing species in the genus, *K. ralla*, a larger, nonisidiate lichen.

Specimens examined (all in US). South Africa. Transvaal: Near junction of Hwy N1 and Njelele Dam road, Grid 2229 DD, *Hale* 76306; 11 km SW of Naboomspruit, Grid 2428 DA, *Hale* 79448; 8.7 km SW of Tinmyne, Grid 2428 BA, *Hale* 79437.

8. **Karoowia perspersa** (Stizenb.) Hale, comb. nov.

Parmelia perspersa Stizenb., Ber. Tätig. St. Gall. Naturw. Gesell. 1888–1889:152. 1890. Type collection: Montis Leonis, Cape Town, Cape Province, South Africa, *MacOwan s.n.* (ZT, lectotype).

Parmelia encrustans Hale, Bot. Not. 124:348. 1971. Type collection: Between O'okiep and Springbok, Cape Province, South Africa, *Almborn* 4792 (LD, holotype; US, isotype).

Xanthoparmelia encrustans (Hale) Hale, Phytol. 28:487. 1974.

Thallus (Fig. 20) saxicolous, subcrustose, thick and areolate-cracked to areolate-bullate at the center with conspicuous marginal lobes, 2–8 cm broad, pale yellow green or darkening at the center; lobes sublinear, 0.3–1.1 mm wide, convex, black-rimmed, contiguous; upper surface continuous, emaculate, shiny to dull and becoming lightly to densely pruinose, transversely cracked with age, soredia and isidia lacking; lower surface pale brown or darkening somewhat, with a sparse to very dense layer of rhizoids and lamellae. Pycnidia common; conidia cylindrical, 0.5 × 5–6 μm. Apothecia commonly developed, initially sessile, becoming adnate and conspicuous with age, 0.5–5 mm in diameter, the disk brown with a pruinose rim; spores subspherical, 4–6 × 7–9 μm.

Chemistry: Hypoprotocetraric, 4-*O*-demethylnotatic, and usnic acids.

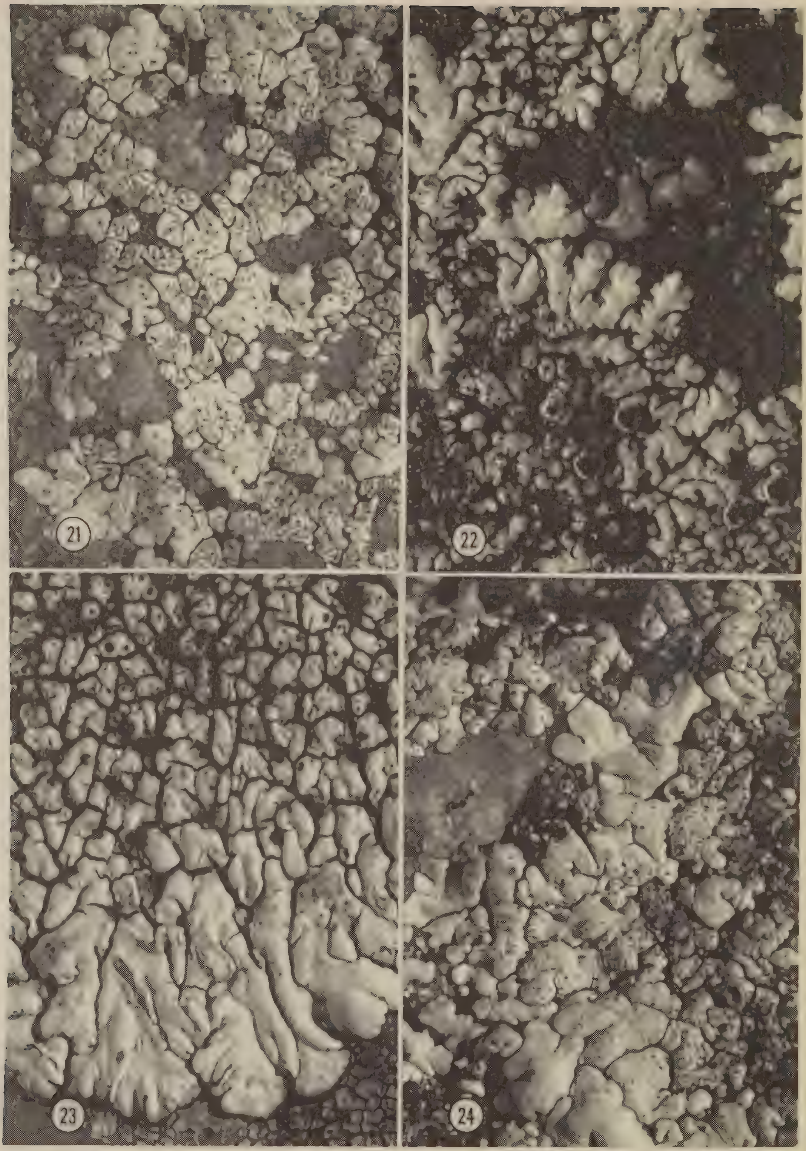
Illustration: Hale, *Bot. Notiser* 124:350. 1971 (Fig. 2A, as *Parmelia encrustans*).

This is the largest and most commonly collected *Karoowia* species. It was long considered to be a *Xanthoparmelia*. The apothecia are sessile and clearly parmelioid from the earliest stages. It is especially common in the Namaqualand karoo of northwestern Cape Province (Map 6), where is occurs on granites, and in the southwestern part of the province on sandstones.

Representative specimens examined (all in US). South Africa. Cape Province: 1 km S of Nuwerus, Grid 3118 AB, *Hale* 72949; Pakhuis Pass, Grid 3218 BB, *Almborn* 4530 (LD); Schoemanshoek, Grid 3322 AC, *Hale* 74883; 32.6 km W of Lainsburg, Grid 3320 AC, *Hale* 77790; 33.8 km W of Dordrecht, Grid 3126 BC, *Hale* 73802; 78.6 km S of Sutherland, Grid 3220 DC, *Hale* 73795.

9. **Karoowia protocetrarica** Hale, sp. nov.

Thallus subcrustaceus, saxicola, lobis subirregularibus, 0.2–0.4 mm latis, appressis, superne continuus, laeviter pruinosus, sorediis isidiisque destitutus, subtus niger, rhizoideis instructus. Apothecia aspicilioidea, sporis nullis.



Figures 21 – 24. Species of *Karoowia*: 21, *K. protocetrarica* (holotype in US); 22, *K. ralla* (*Hale* 73718); 23, *K. salazinica* (*Hale* 73903); 24, *K. saxeti* (*Hale* 79251). See Fig. 13 for scale.

Thallus (Fig. 21) saxicolous, subcrustose, dispersed to continuous and areolate-cracked, 4–6 cm broad, bright yellow green; lobes subirregular, 0.2–0.4 mm wide, flat and appressed, short and irregularly branched, contiguous; upper surface continuous, emaculate, dull and lightly pruinose with age, soredia and isidia lacking; lower surface with a pale spongy layer of rhizoids and lamellae. Pycnidia common; conidia cylindrical, 0.5 × 6–9 μm. Apothecia immersed and aspicilioid, lacking a rim, 0.2–0.3 mm in diameter; spores not developed.

Chemistry: Protocetraric and usnic acids.

Type collection: On steep uplifted sandstone cliff, Schoemanshoek, 24 km N of Oudtshoorn on west side of Hwy R29, Cape Province, South Africa, Grid 3322 AC, *Hale* 71023, 31 Jan. 1986 (US, holotype).

Externally this rare species is indistinguishable from *K. adligans* and *K. leptoplaca*, but the chemistry is distinctive. It is known only from the type collection (Map 8).

10. **Karoowia ralla** (Brusse) Hale, comb. nov.

Parmelia ralla Brusse, Mycotaxon 27:240. 1986. Type collection: Seweweekspoort, Swartberg Range, Cape Province, South Africa, Grid 3321 AD, *Brusse* 4935 (PRE, holotype; BM, COLO, LD, MEL, US, isotypes).

Thallus (Fig. 22) saxicolous, subcrustose, more or less dispersed with a lobate center, at most weakly areolate, 2–4 cm broad, yellowish green; lobes subirregular, 0.2–0.5 mm wide, rather short and irregularly branched, flat, minutely lobulate along the margins, contiguous; upper surface continuous, emaculate, shiny to dull, pruinose at the tips, soredia and isidia lacking; lower surface pale brown with a well developed spongy layer of rhizoids and poorly developed lamellae. Pycnidia common; conidia cylindrical, 9–11 μm. Apothecia initially aspicilioid, mostly emergent and sessile at maturity, 0.3–0.5 mm in diameter; spores 5–6 × 10–14 μm.

Chemistry: Norlobaridone and usnic acid.

Illustration: Brusse, *Mycotaxon* 27:244. 1986 (Fig. 6).

This species is relatively rare but widespread from central Transvaal southward to Lesotho and Transkei and westward into Cape Province (Map 7). There is one remarkable disjunct collection from south-central Australia.

Representative specimens examined (all in US). South Africa. Transvaal: 11 km SW Naboomspruit, Grid 2428 DA, *Hale* 79444. Orange Free State: Golden Gate National Park, Grid 2828 BC, *Hale* 74107. Transkei: Moordenaarsnek, Grid 3028 DC, *Hale* 76903. Cape Province: Winterhoek Pass, Grid 3124 BD, *Hale* 80523; Seweweekspoort, Grid 3321 AD, *Hale* 73718. Lesotho: 9 km W of Mpiti, Grid 3028 BA, *Hale* 81287. Australia. South Australia: Brachina Gorge, Flinders Mountains, *Hale* 58424.

11. **Karoowia salazinica** Hale, sp. nov.

Thallus subcrustaceus, centrum versus areolato-rimosus, saxicola, lobis subirregularibus, convexis, superne continuus, pruinosus aetate, subtus rhizoideis instructus. Apothecia emergentia ad sessilia, 0.5–1 mm lata, sporis 4–6 × 6–9 μm.

Thallus saxicolous (Fig. 23), subcrustose with an areolate-cracked center and distinct marginal lobation, 3–6 cm broad, darkish yellow green; lobes subirregular, 0.3–0.8 mm wide, rather short and irregularly branched, flat to convex, contiguous to subimbricate; upper surface continuous, emaculate, pruinose with age at the tips, transversely cracked, soredia and isidia lacking; lower surface pale with a spongy layer of rhizoids and lamellae. Pycnidia well developed; conidia cylindrical, 0.5 × 5–7 μm. Apothecia numerous, initially aspicilioid, becoming emergent to sessile, 0.5–1 mm in diameter, the disc convex, dark brown; hymenium 55 μm high; spores subspherical, 4–6 × 6–9 μm.

Chemistry: Salazinic, consalazinic, and usnic acids.

Type collection: low sandstone ridges in karoo, 11 km SE of Middelpos on Hwy R354, Cape Province, South Africa, Grid 3120 CD, *Hale* 73902, 29 Jan. 1986 (US, holotype).

Only two other species in the genus, *K. leptoplaca* and *K. subchalybaeizans*, have salazinic acid as the main component. *Karoowia leptoplaca* differs in having a bright yellow, more appressed thallus with flattened lobes, a black lower surface, and persistently immersed apothecia. In addition, *K. salazinica* occurs on sandstones south of the basaltic rock area in the arid Great Karoo where *K. leptoplaca* is so common (Map 3). *Karoowia subchalybaeizans* has a lobate center, darker, yellowish green lobes, and initially sessile apothecia.

Representative specimens examined (all in US). South Africa. Cape Province: 22 km NE of Prince

Albert, Grid 3322 AB, *Hale* 75903; Spektakel Pass, Grid 2917 DA, *Hale* 79536; 17.5 km SE of Murraysburg, Grid 3123 DD, *Hale* 80449.

12. **Karoowia saxeti** (Stizenb.) Hale, comb. nov.

Parmelia saxeti Stizenb., Ber. Tätig. St. Gall. Naturw. Gesell. 1888–1889:153. 1890. Type collection: Lubombo Mountains, Natal, South Africa, *Wilms s.n.* (ZT, lectotype).

Parmelia squamariaeformis Gyelnik, Fedde, Repert. Spec. Nov. Reg. Veg. 36:163. 1934. Type collection: Tamsui, Taiwan, *Faurie* 76 (BP, lectotype).

Parmelia seto-maritima Asahina, Jour. Jap. Bot. 36:228. 1961. Type collection: Marugame, Shikoku, Japan, *Togashi* 61511 (TNS, holotype; H, isotype).

Thallus saxicolous (Figs. 24, 25), subcrustose, more or less lobate at the center with clearly lobed margins, 2–6 cm broad, pale yellowish green; lobes subirregular, variable. 0.4–1.1 mm wide, sparingly branched, flat to more or less convex, contiguous to subimbricate; upper surface continuous, emaculate, shiny, somewhat transversely cracked with age, moderately isidiate, the isidia subglobose to cylindrical, 0.06–0.08 mm in diameter, 0.1–0.2 mm high, darkening at the tips, unbranched; lower surface black with a spongy rhizoidal and lamellar layer. Pycnidia common; conidia cylindrical, 0.5 × 6–8 μm. Apothecia initially aspicilioid but soon emergent and sessile, the disk brown, 0.5–0.8 mm in diameter; spores 5–6 × 9–11 μm.

Chemistry: Stictic, constictic, hypostictic (±trace), hyposalazinic (±trace), and usnic acids.

Karoowia saxeti is easily recognized by chemistry and the presence of isidia. It is the most widespread species in the genus on the world level and occurs commonly on sandstones from Transvaal south to Transkei and Natal in South Africa, in South West Africa/Namibia and Angola (Map 8), and in Brazil, Uruguay, Australia, Hong Kong, Taiwan, Japan, and India.

Representative specimens examined (all in US). Angola. Huila: Bimbe, *Degelius* s.n. South West Africa/Namibia: Waterberg Plateau National Park, Grid 2017 CA, *Hale* 80980. South Africa. Venda: Tschikadeni Mine area, Grid 2231 DB, *Hale* 79121. Transvaal: 2 km S of Lejuma Summit, Soutpansberg Mountains, Grid 2329 AB, *Hale* 72944. Natal: Umtamvuna Nature Reserve, Grid 3130 AA, *Hale* 76783; Mtunzini, Grid 2931 BA, *Hoeg* s.n. (LD). Cape Province: 20 km WSW of Elliott, Grid 3127 BC, *Hale* 72943. Lesotho: 1 km E of Mpiti, Grid 3028 BA, *Hale* 81378. Australia. Queensland: Horseshoe Bay near Bowen, *Hale* 65001. Hong Kong: New Territories, *Hale* 50992. India. Karnataka: Belgaum, *Hale* 47656. Uruguay. Durazno: Arroyo El Cordobes, *Osorio* 2813. Brazil. Rio Grande do Sul: Sao Sepe, *Fleig* 2597.

13. **Karoowia scitula** (Brusse) Hale, comb. nov.

Parmelia scitula Brusse, Bothalia 15:317. 1984. Type collection: 8 km S of Lainsburg, Cape Province, South Africa, Grid 3320 BB, *Brusse* 3522 (PRE, holotype; LD, isotype).

Thallus saxicolous (Fig. 26), subcrustose, dispersed and lobate to weakly areolate at the center and with effigurate-lobate margins, 2–10 cm broad, yellowish green; lobes sublinear, 0.3–0.5 mm wide, convex, dichotomously branched, contiguous to subimbricate; upper surface continuous, emaculate, shiny to dull, rarely pruinose, transversely cracked, soredia and isidia lacking; lower surface pale or darker brown with a pale spongy rhizoidal or lamellar layer. Pycnidia common; conidia cylindrical to weakly bifusiform, 0.5 × 6–7 μm long. Apothecia numerous, initially immersed but soon emergent and sessile, 0.5–0.8 mm in diameter; spores subspherical, 4–6 × 6–9 μm.

Chemistry: Lecanoric and usnic acids.

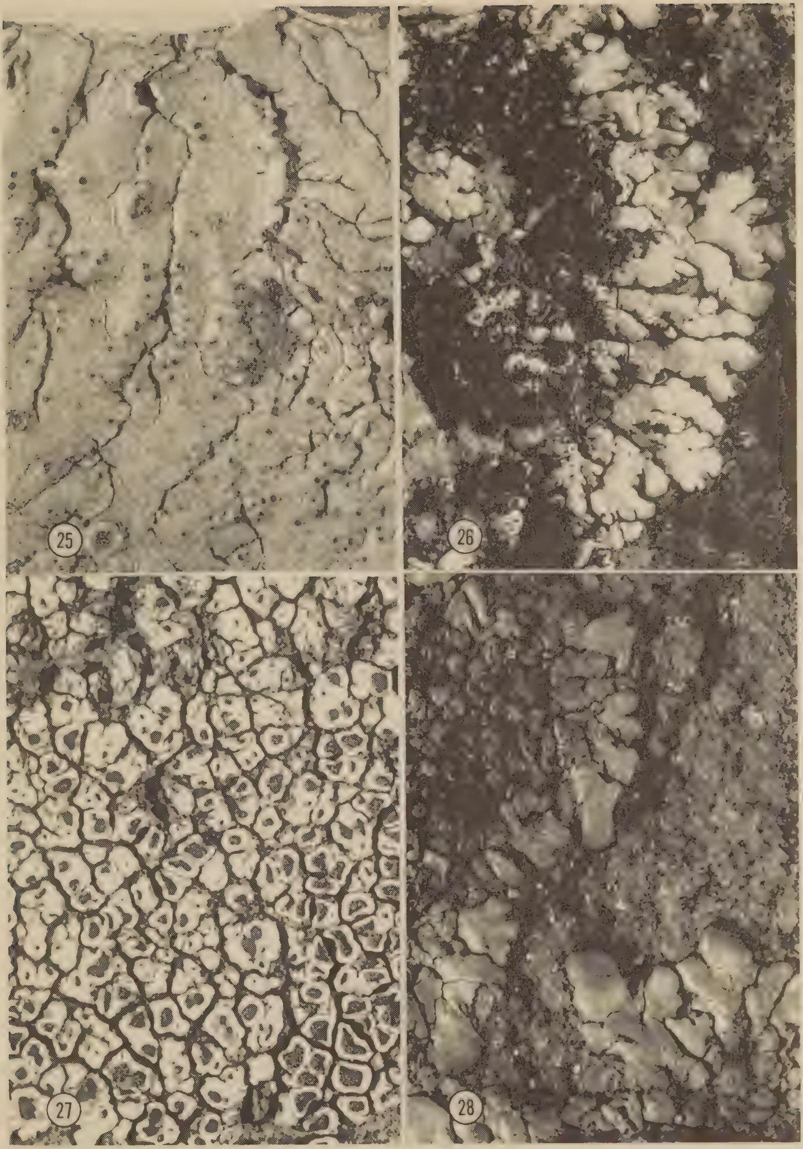
Illustration: Brusse, *Bothalia* 15:318. 1984 (Fig. 7).

The presence of lecanoric acid and the conspicuous thallus with convex lobes and sessile apothecia characterize this species. It occurs on sandstones (granite in Namaqualand) over a wide area in southern Africa (Map 9), from South West Africa/Namibia southward into western Cape Province and in eastern Cape Province, Orange Free State, Lesotho, and Natal.

Representative specimens examined (all in US). South West Africa/Namibia: 14.2 km S of Otjiwarongo, Grid 2016 DA, *Hale* 80906. Lesotho: 6.3 km SE of Oxbow Lodge, Grid 2828 DC, *Hale* 81458. Orange Free State: Ladybrand, Grid 2927 AB, *Maas Geesteranus* 11967 (LD). Natal: Bushman's Nek, Grid 2929 CC, *Hale* 76556. Cape Province: W of Bitterfontein, Grid 3118 AB, *Hale* 79804; Mountain Zebra National Park, Grid 3225 AB, *Hale* 77283.

14. **Karoowia spissa** (Brusse) Hale, comb. nov.

Parmelia spissa Brusse, Mycotaxon 31:158. 1988. Type collection: 31 km S Witsieshoek, Mont-aux-Sources, Natal, S. Africa, Grid 2828 DD, *Brusse* 4524, 21 Jan. 1986 (PRE, holotype; LD, isotype).



Figures 25–28. Species of *Karoowia*: 25, *K. saxeti* (lectotype in ZT); 26, *K. scitula* (*Hale* 77283); 27, *K. spissa* (*Hale* 74889); 28, *K. subchalybaeizans* (holotype in US). See Fig. 13 for scale.

Thallus saxicolous (Fig. 27), subcrustose, weakly lobate to distinctly areolate at the center, 2–4 cm broad, light yellowish green; lobes short and subirregular, 0.2–0.5 mm wide, more or less convex, separate and scattered to contiguous or subimbricate; upper surface continuous, emaculate, shiny to dull, pruinose with age, soredia and isidia lacking; lower surface pale brown with a pale spongy layer of rhizoids and lamellae. Pycnidia common; conidia cylindrical, 0.5 × 6–9 µm. Apothecia initially aspicilioid but soon emergent and sessile, 0.3–1 mm in diameter, the rim becoming pruinose; spores subspherical, 5–6 × 8–9 µm.

Chemistry: Evernic (major), lecanoric (minor), and usnic acids.

Illustration: Brusse, *Mycotaxon* 31:160. 1988 (Fig. 5).

This is a rather common species in eastern Cape Province and Lesotho, occurring in a restricted area at over 3000 m on the basaltic escarpments and at lower elevations on sandstone in the Drakensberg foothills from Orange Free State and Natal into eastern Cape Province (Map 10). In this range it is sympatric with evernic acid-containing *K. insipida*, a more appressed, flat lobed species with more persistently aspicilioid apothecia.

Representative specimens examined (all in US). South Africa. Orange Free State: Golden Gate National Park, Grid 2828 BC, *Hale* 74893. Natal: Mzintlava River bridge on R394, Grid 3029 AD, *Hale* 81265. Lesotho: Sani Pass, Grid 2929 CB, *Hale* 74889, 74894.

15. **Karoowia squamatica** (Brusse) Hale, comb. nov.

Parmelia squamatica Brusse, Mycotaxon 27:242. 1986. Type collection: Pakhuis Pass, Cape Province, South Africa, Grid 3219 AA, *Brusse* 772 8-2-1, 2 Aug. 1977 (J, holotype; not available for study).

Thallus saxicolous, subcrustose and strongly areolate at the center with an effigurate-lobate margin, 2–5 cm broad, yellowish green; lobes subirregular, 0.2–0.7 mm wide, flat and appressed, contiguous; upper surface continuous, emaculate, soredia and isidia lacking; lower surface pale brown with a spongy rhizoidal or lamellar layer. Pycnidia common; conidia cylindrical, 0.5 × 7–11 µm. Apothecia lacking.

Chemistry: Squamatic and usnic acids.

Illustration: Brusse, *Mycotaxon* 27:244. 1986 (Fig. 7).

I was not able to recollect this very rare species, known only in Namaqualand, nor was the original author (personal communication). It appears to be related to salazinic acid-containing *K. leptoplaca*.

16. **Karoowia subchalybaeizans** Hale, sp. nov.

Thallus subcrustaceus, 2–3 mm latus, lobis subirregularibus, 0.3–0.7 mm latis, superne continuus, sorediis isidiisque destitutus, subtus pallide brunneus, rhizoideis instructus.

Thallus saxicolous (Fig. 28), subcrustose, somewhat dispersed to lobate or weakly areolate at the center, 2–5 cm broad, dark yellowish green; lobes subirregular, 0.3–0.7 mm wide, short and irregularly dichotomously branched, weakly to distinctly convex, contiguous; upper surface continuous, shiny or dull and becoming light pruinose, transversely cracked with age, soredia and isidia lacking; lower surface pale brown with a dense layer of rhizoids and well developed lamellae. Pycnidia well developed; conidia cylindrical, 0.5 × 7–9 µm. Apothecia numerous, emergent initially to sessile at maturity, the disc dark brown, 1–3 mm in diameter; spores subspherical, 4–6 × 7–9 µm.

Chemistry: Salazinic, consalazinic, norstictic (±trace), hypostictic (±trace), hyposalazinic (±trace), and usnic acids, chalybaeizans unknown, atranorin (±).

Type collection: On dolerite, 54.7 km E of Willowmore (29.5 km W of Steytlerville) on Hwy R329), elev. 550 m, Cape Province, South Africa, Grid 3324 AC, *Hale* 77655, 18 Oct. 1986 (US, holotype; PRE, isotype).

This species occurs rarely from Namaqualand southward to the Cape region and eastward into southern Cape Province (Map 10). It does not seem to be related to any others in the genus and in fact would be identified as a *Xanthoparmelia* until the nature of the lower surface is recognized.

Specimens examined (all in US). Cape Province: 1 km E of Springbok, Grid 2917 DB, *Hale* 79658; Bainskloof Pass, Grid 3319 CA, *Hale* 72970; 22.6 km W of junction N7 and R364, Grid 3218 BA, *Hale* 80001; 21 km S of Worcester, Grid 3319 CB, *Hale* 78189; 54.7 km E of Willowmore, Grid 3324 AC, *Hale* 77652.

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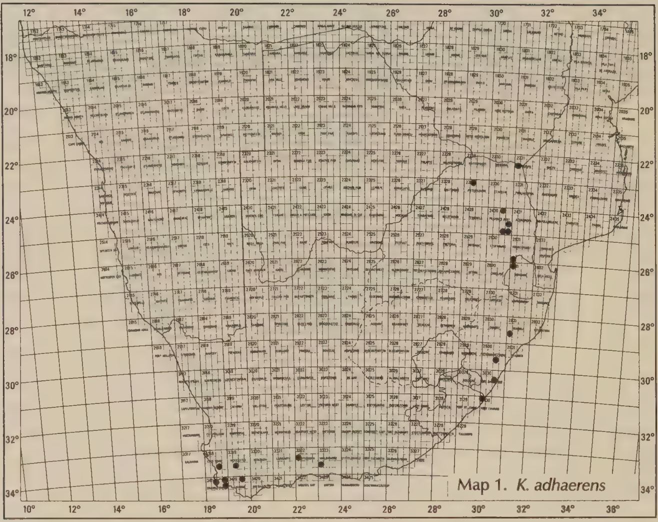
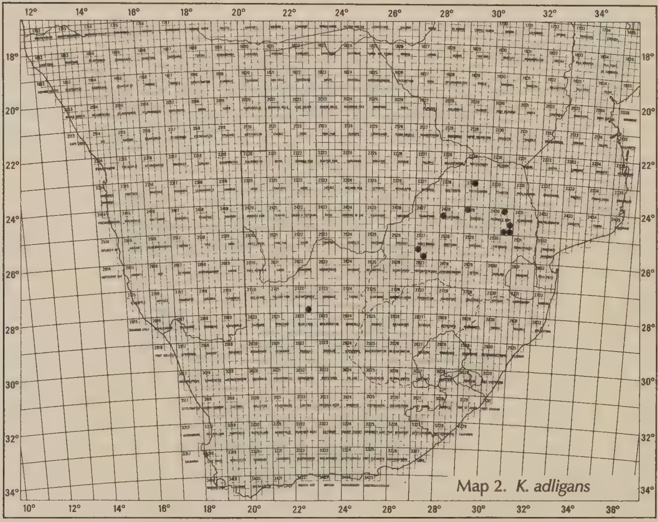
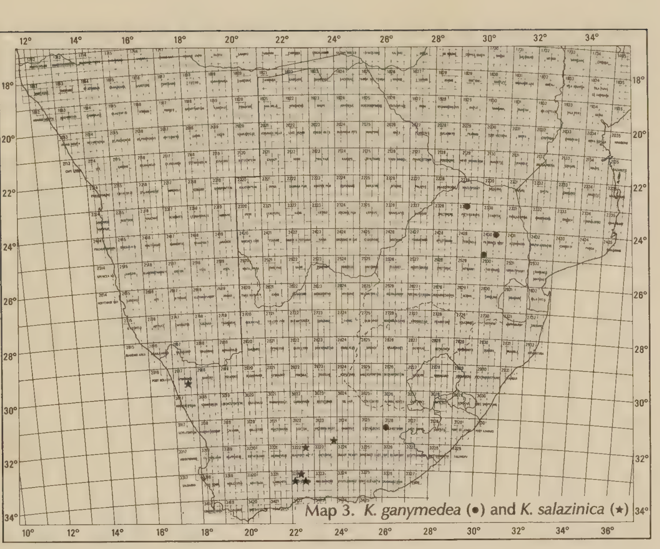
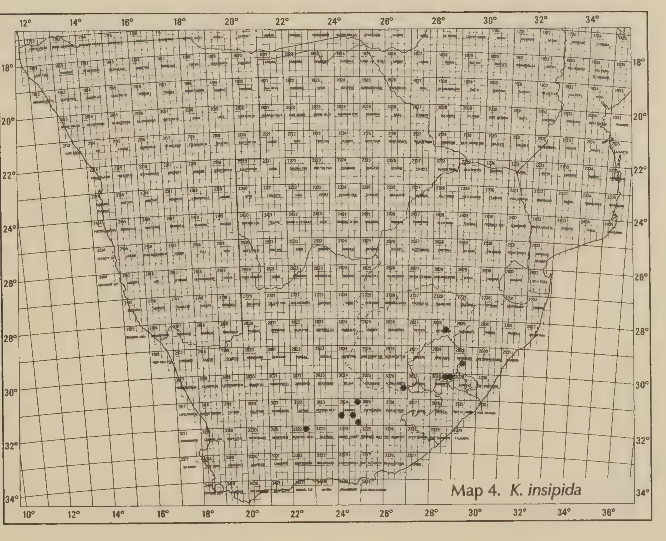
Krog, H. and T. D. V. Swinscow. 1987. New species and new combinations in some parmelioid lichen genera, with special emphasis on East African taxa. *Lichenologist* 19:419 – 431.


Map 1. *K. adhaerens*

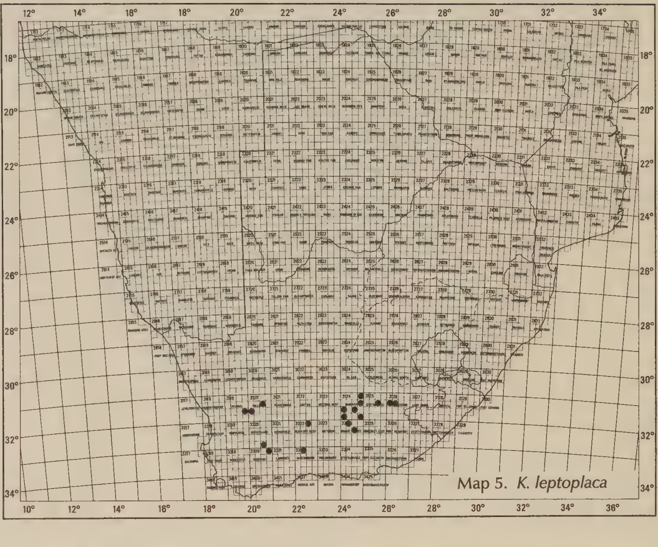

Map 2. *K. adligans*



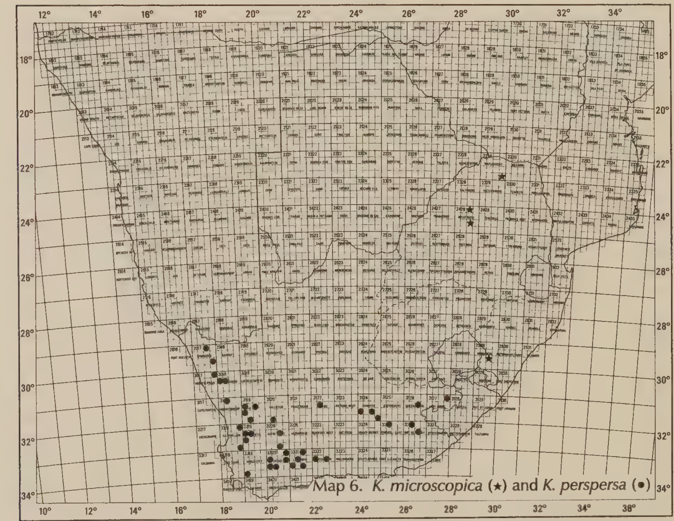
Map 3. *K. ganymedea* (●) and *K. salazinica* (★)



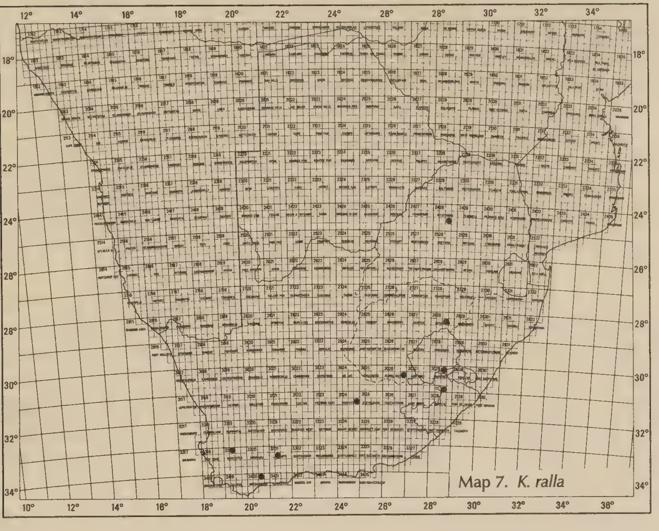
Map 4. *K. insipida*



Map 5. *K. leptoplaca*



Map 6. *K. microscopica* (★) and *K. perspersa* (●)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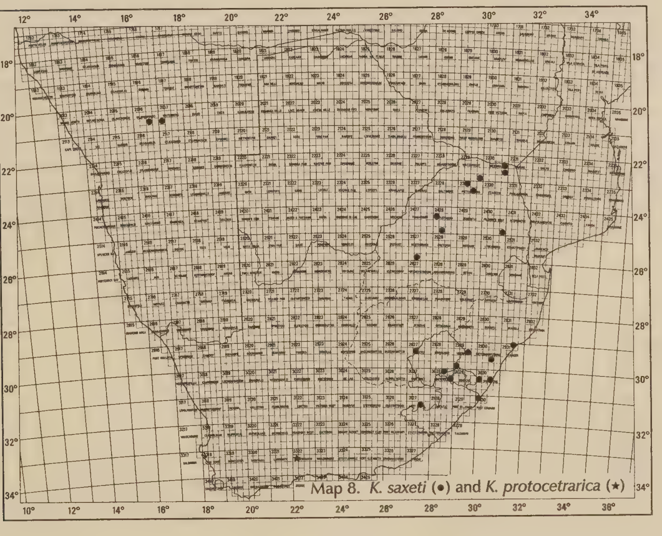
Map 7. *K. ralla*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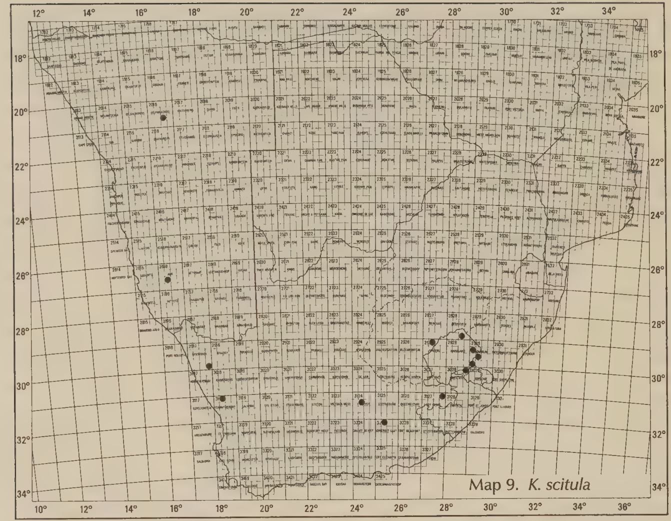
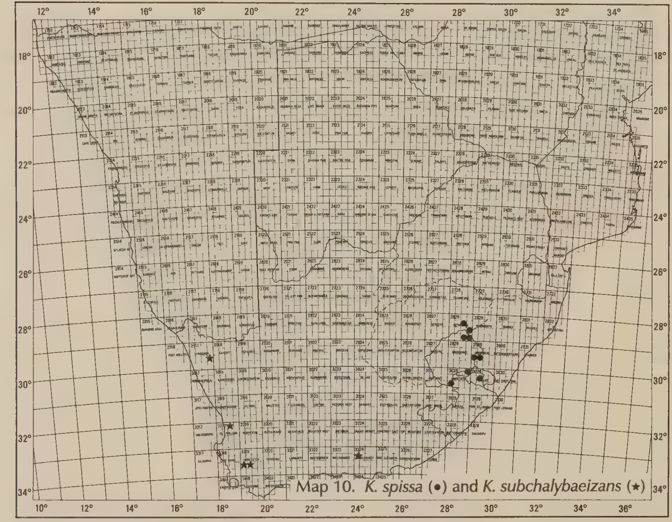
Map 8. *K. saxeti* (•) and *K. protocetrarica* (⋆)



Map 9. *K. scitula*



Map 10. *K. spissa* (•) and *K. subchalybaeizans* (★)

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CHARLES CHUPP'S "A MONOGRAPH OF THE FUNGUS GENUS CERCOSPORA" AGAIN AVAILABLE

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This book, in its original hardbound edition, can be obtained from MYCOTAXON, LTD., P.O. Box 264, Ithaca, NY 14851-0264, at a cost of US$ 20.00, *postpaid* to any address in the world, as long as supplies last. For airmail shipment, add $15.00.

MYCOTAXON

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MYCOTAXON

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A NEW ASCOSPOROGENOUS YEAST GENUS: YAMADAZYMA GEN. NOV.

GENEVIEVE BILLON-GRAND

Université Lyon I, ICBMC, Laboratoire de Biologie Végétale, Section Levures, Bât. 405, 43 Bd du 11 novembre 1918, 69622 VILLEURBANNE Cedex, FRANCE

Summary

The genus *Pichia* is very heterogeneous as to the coenzyme Q system: 67 species are characterized by a coenzyme Q7, 4 species by a coenzyme Q8 and 20 by a coenzyme Q9. We propose the new ascoporogenous genus *Yamadazyma* for those species equipped with the coenzyme Q_9 and with hat-shaped ascospores.

Since Hansen established the genus *Pichia* in 1904, the definition of this taxon has changed considerably in order to accommodate the ever increasing number of new species assigned to it. This genus was very heterogeneous and the ascospores appeared spheroïdal, hat-shaped or Saturn-shaped.

Kurtzman and Smiley (1974) transferred two round-spored species to the genus *Debaryomyces* because their ascospores appeared roughened and typical of *Debaryomyces* by scanning electron microscopy; furthermore, these species were Q9-equipped as all species of the genus *Debaryomyces* (Yamada and Kondo, 1972; Yamada et al., 1976). Kurtzman et al. (1980) transferred three other round-spored species to the genus *Issatchenkia*, because their ascospores appeared roughened; they were Q7-equipped (Yamada et al., 1973). Only four round-spored species remained in the genus *Pichia* (Kurtzman, 1984); these species were Q9-equipped and we have suggested to transfer them to the genus *Debaryomyces* subject to investigating their ascospores by scanning electron microscopy (Billon-Grand, 1988).

The species with Saturn-shaped ascospores were proposed by Kurtzman (1984) for transference to the genus *Williopsis* Zender, as Von Arx et al. (1977) did for the Saturn-spored *Hansenula* species.

Among the 85 *Pichia* species with hat-shaped ascospores, 65 species are characterized by a coenzyme Q7, 4 species by a coenzyme Q8 and 16 species by a coenzyme Q9 (Yamada et al., 1973, Billon-Grand, 1985). In order to clarify the taxonomy of the genus *Pichia*, we propose a new ascosporogenous yeast genus for the 16 species equipped with the CoQ_9 system and with hat-shaped ascospores: the genus *Yamadazyma*, gen. nov.

This genus is named in honour of Professor Yuzo Yamada, Shizuoka University, Department of Agricultural Chemistry, Applied Microbiology Laboratory, Shizuoka, Japan, in recognition of his contribution to yeast taxonomy, especially his studies of the coenzyme Q system of asporogenous and ascosporogenous yeasts.

Latin diagnosis:

Cellulae globosae vel cylindricae per gemmationem multilateralem propagant. Pseudohyphae praesentes. Ascosporae pileiformes, 1 to 4 in quoque asco. Ascosporae maturae ex ascis liberantur. Fermentatio adest. Ad crescentiam vitaminae externae necessariae sunt. Systema coenzymatis Q9 adest.

Species typica: *Yamadazyma philogaea* (Van der Walt et Johannsen) Billon-Grand.

Cells are globose to cylindrical, reproducing by multilateral budding. Pseudophyphae are present. Ascospores are hat-shaped, 1 to 4 per ascus. Mature spores are easily released from the ascus, except for one species. Fermentation is usually present. Growth in vitamin free medium is usually negative. The coenzyme Q system is Q9.

The type species is: *Yamadazyma philogaea* (Van der Walt et Johannsen) Billon-Grand, comb. nov. (basionym: *Pichia philogaea* Van der Walt et Johannsen, Antonie van Leeuwenhoek, **41**: 173, 1975); type strain: CBS 6696.

The 15 other species of the new genus *Yamadazyma* are:

-*Yamadazyma acaciae* (Van der Walt) Billon-Grand, comb. nov. (basionym: *Pichia acaciae* Van der Walt, Antonie van Leeuwenhoek, 32: 159, 1966); type strain: CBS 5656.

-*Yamadazyma besseyi* (Kurtzman et Wickerham) Billon-Grand, comb. nov. (basionym: *Pichia besseyi* Kurtzman et Wickerham, Antonie van Leeuwenhoek, **38**: 50, 1972); type strain: CBS 6343.

-*Yamadazyma castillae* (Santa Maria et Garcia Aser) Billon-Grand, comb. nov. (basionym: *Pichia castillae* Santa Maria et Garcia Aser, Bol. I.N.I.A., **62**: 53, 1970); type strain: CBS 6053.

-*Yamadazyma farinosa* (Lindner) Billon-Grand, comb. nov. (basionym: *Saccharomyces farinosus* Lindner, Wochenschr. Brau., 153, 1894); type strain: CBS 185.

-*Yamadazyma guilliermondii* (Wickerham) Billon-Grand, comb. nov. (basionym: *Pichia guilliermondii* Wickerham, J. Bacteriol., **92**: 1269, 1966); type strain: CBS 2031.

-*Yamadazyma haplophila* (Shifrine et Phaff) Billon-Grand, comb. nov. (basionym: *Pichia haplophila* Shifrine et Phaff, Mycologia, **48**: 45, 1956); type strain: CBS 2028.

-*Yamadazyma inositovora* (Golubev, Blagodatskaya, Suetin et Trotsenko) Billon-Grand, comb. nov. (basionym: *Pichia inositovora* Golubev, Blagodatskaya, Suetin et Trotsenko, Inter. J. System. Bacteriol., **31**: 91, 1981); type strain: CBS 8006.

-*Yamadazyma media* (Boidin, Pignal, Lehodey, Vey et Abadie) Billon-Grand, comb. nov. (basionym: *Pichia media* Boidin, Pignal, Lehodey, Vey et Abadie, Bull. Soc. Mycol. France, **80**: 438, 1966); type strain: CBS 5521.

-*Yamadazyma mexicana* (Miranda, Holzschu, Phaff et Starmer) Billon-Grand, comb. nov. (basionym: *Pichia mexicana* Miranda, Holzschu, Phaff et Starmer, Inter. J. System. Bacteriol., **32**: 103, 1982); type strain: CBS 7066.

-*Yamadazyma nakazawae* (Kodama) Billon-Grand, comb. nov. (basionym: *Pichia nakazawae* Kodama, J. Ferment. Technol., **53**: 626, 1975); type strain: CBS 6700.

-*Yamadazyma ohmeri* (Etchells et Bell) Billon-Grand, comb. nov. (basionym: *Endomycopsis ohmeri* Etchells et Bell, Food Technol., **4**: 81, 1950); type strain: CBS 5367.

-*Yamadazyma scolyti* (Phaff et Yoneyama) Billon-Grand, comb. nov. (basionym: *Endomycopsis scolyti* Phaff et Yoneyama, Antonie van Leeuwenhoek, **27**: 201, 1961); type strain: CBS 4802.

-*Yamadazyma segobiensis* (Santa Maria et Garcia Aser) Billon-Grand, comb. nov. (basionym: *Pichia segobiensis* Santa Maria et Garcia Aser, Bol. I.N.I.A., **5**: 49, 1977); type strain: CBS 6857.

-*Yamadazyma spartinae* (Ahearn, Yarrow et Meyers) Billon-Grand, comb. nov. (basionym: *Pichia spartinae* Ahearn, Yarrow et Meyers, Antonie van Leeuwenhoek, **36**: 505, 1970); type strain: CBS 6059.

-*Yamadazyma stipitis* (Pignal) Billon-Grand, comb. nov. (basionym: *Pichia stipitis* Pignal, Bull. Soc. Linéenne Lyon, 4: 168, 1967); type strain: CBS 5773.

The genus *Yamadazyma* is placed in the family *Endomycetaceae.*

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LEPTOSPHAERIA PIMPINELLAE AND ITS PHOMA ANAMORPH

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On a trip to Israel in 1987, R. Lowen collected a Leptosphaeria on blackened stems of Pimpinella anisum L. that does not fit any published descriptions (Holm, 1957; Müller, 1950; Shoemaker, 1984). A Phoma anamorph was derived from cultures of single ascospores and was also subsequently found on the host. The holomorph is described and illustrated.

Leptosphaeria pimpinellae Lowen & Sivanesan sp. nov. (Figs. 1,2)

Anamorph: Phoma sp.

Ascomata dispersa vel aggregata, aliquando confluentibus, immersa, saepe superficialia, atra, globosa, basali compressa, 300-400 μm lata, usque 500 μm alta, cum pilis sparsis dispersus, sine colore. Rostrum pleurumque uni et centralis, raro binis, 60-60 μm altis, sine periphyses. Ostiolum apicali, 25-70 μm latis. Paries ascomati brunneis,textura angularis, 50-75 μm latis, ex cellulis interno scleroplectenchymatis, externo pseudoparenchymatis compositus. Pseudoparaphyses numerosae, filiformes, septatae, sine colore, ramosae, 1.5 μm lata. Asci bitunicati, clavati, brevipedicellati, octospori, 90-120 X 14-16 μm. Ascosporae biseriatae vel multiseriatae in asco, fusiformes, 5-6(-10) transversaliter septatae, in medio constrictae aliquando ceterus septa, pallide brunneae, guttulatae, laeves, rectus vel leviter curvata, 50-65 X 5.5-6.5 μm, cum appendiculatae globosus, terminalis, gelatinoso, raro strato tenui gelatinoso totam sporam cingens. Conidiomata pycnidia, ascomata similis, parva, usque 300 μm diam, roseus contentu. Conidia brevicylindrica, aseptata, biguttulata, sine colore, 4-4.5 X 1.2-1.8 μm.

Holotype: Israel: Mt. Carmel, Beit Oren Forest, wadi near Kibbutz Oren. On dead, blackened, still standing stems of _Pimpinella anisum_ L., 9 Dec 1987, R. Lowen 523-88, NY; Isotype IMI 328948.

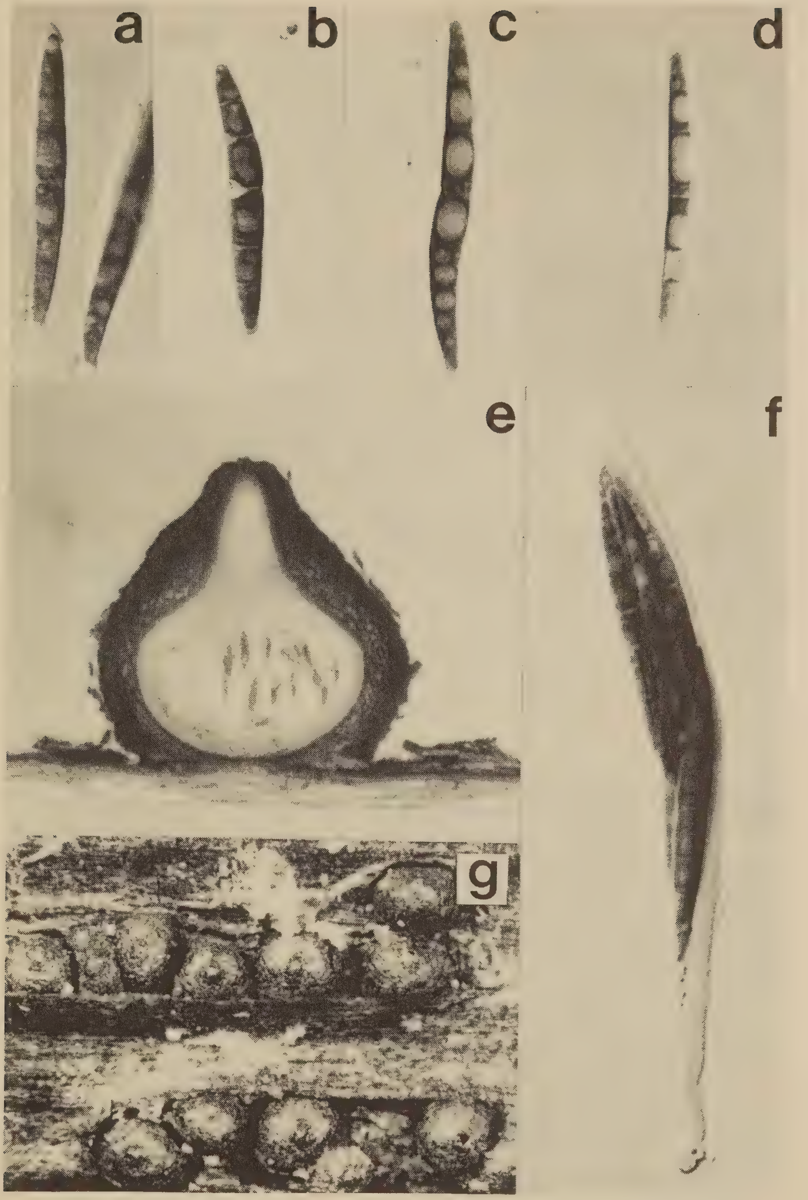
Ascomata scattered to gregarious, sometimes confluent, immersed, becoming superficial, black, globose with a flattened base, 300-400 µm wide, up to 500 µm high, with sparse, scattered colorless hairs. Beak usually one and central, rarely two, approximately 60 x 60 µm high, without periphyses. Ostiole apical, 25-70 µm wide. Peridium surface brown, textura angularis, in longitudinal section 50-75 µm thick, of six to nine layers of scleroplectenchymatous cells toward the outside and pseudoparenchymatous cells toward the inside. Pseudoparaphyses numerous, septate, colorless, branched, up to 1.5 µm thick. _Asci_ bitunicate, clavate, short-stalked, 8-spored, 120 x 14-16 µm. _Ascospores_ biseriate to multiseriate in the ascus, fusiform, transversely 5-6(-10) septate, constricted in mid septum, occasionally in other septa, pale brown, guttulate, smooth, straight to slightly curved, 50-65 x 5.5-6.5 µm, with a globose, terminal, mucilaginous appendage at each end, rarely surrounded by a thin mucilaginous sheath. _Conidiomata_ pycnidial, similar to ascomata, up to 300 µm diam, contents pink. _Conidia_ short cylindrical, aseptate, biguttulate, colorless, 4-5.5 x 1.2-1.8 µm, formed on phialidic conidiogenous cells 6-12 X 3 µm at the base, tapering to 1 µm at the apex, apex flared, arising from cells lining the cavity of the pycnidium.

Culture study: Cultures were grown on CMD (cornmeal dextrose agar, Difco) and OM (oat meal agar, Smith and Onions, 1983) in diffuse daylight at 20°C. Ascospores germinating from one or both end cells, sometimes from the other cells, remaining viable after being frozen at 0°C for 24 h. Mycelium immersed, forming black, rhizoidal branching strands on CMD, much white aerial mycelia on OM, leading edge irregular, reverse black. Irregular conidiomata forming in one week at sites of mycelial aggregation, oozing copious pink slime containing conidia. Conidiomata becoming more regular after 6 weeks in culture, often 125-250 µm diam.

Leptosphaeria _planiuscula_ (Reiss.) Ces. & De Not. is the closest species to _L. pimpinellae_ with terminal appendaged ascospores but the ascospores are 5-septate,

---

Fig. 1. _Leptosphaeria pimpinellae_, teleomorph. a-d. ascospores (X 1000); e. section of ascoma (X 100); f. ascus (X 1000); g. ascomata on host (X 25).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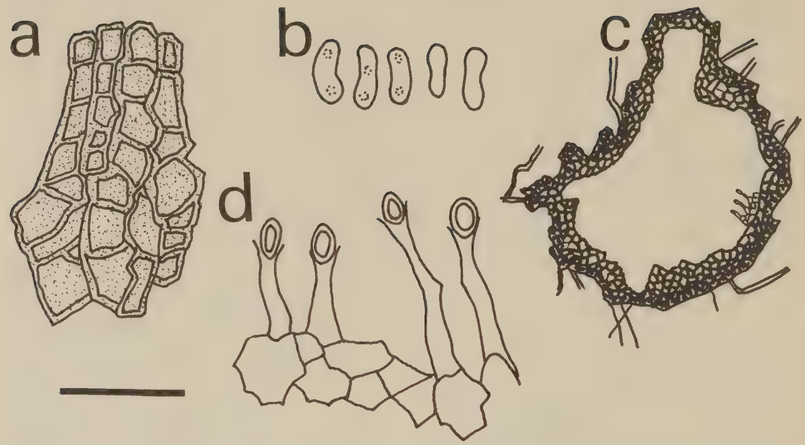

Fig. 2. *Leptosphaeria pimpinellae*, anamorph. a. cells on surface of peridium; b. conidia; c. section of conidioma; d. conidiophores with developing conidia. Bar a,b,d = 10 µm; c = 100 µm.

Table 1.
Comparison of species of *Leptosphaeria* on members of Umbelliferae

Species	Host	No. of septa in ascospore	Ascospore size (µm)
L.cornuta E.Müller (1953)	*Laserpitium*	4(-5)	35-45 X 5
L.foeniculacea Fabre (1883)	*Foeniculum*	4(-5)	40 X 6
L.foeniculi Gonz. (1924)	*Foeniculum*	4(-5)	18-24 X 5-7
L.ladina E.Müller (1950)*	*Laserpitium*	6-8	40-60 X 6-8
L. libanotis (Fuckel)Neissl in Kunze (1876)	*Angelica, Daucus, Seseli*	3	18-22 X 5.5-7
L.pimpinellae Lowen & Sivan.(1989)	*Pimpinella*	5-6(-10)	50-60 X 5.5-6.5
L.sileris Bres. (1926)	*Laserpitium*	3-5	36-50 X 4-5
L.simmonsii Sacc. (1920)	*Heracleum*	3	35-40 X 4.5

**Nodulosphaeria ladina* (Müller) Holm (1957)

asci distinctly 4-spored (Shoemaker, 1984), and an anamorphic state is lacking. Many species of Leptosphaeria with Phoma anamorphs have been described (Sivanesan, 1984). Among these L. acuta (Fuckel) P. Karst. appears to be the most similar to L. pimpinellae in the ascospore and conidial morphology. Terminal appendages and sheaths, however, are not found on the ascospores. Although conidial morphological differences are insignificant between these two species, similar minor differences are
also generally true between many species of Phoma which have been distinguished mainly on host basis. Furthermore L. acuta is restricted to species of the host genus Urtica. The host Pimpinella is a member of the family Umbelliferae. About eight species of Leptosphaeria (see table 1) have been described on other members of this family. All species except L. ladina E. Müller (1950) have typically 3- or 4- or rarely 5-septate ascospores. The ascospores in L. ladina are 6-8-septate with terminal appendages but the third cell is conspicuously enlarged.

We wish to thank C.T. Rogerson for his helpful comments and M.E. Barr Bigelow and R.A. Shoemaker for serving as pre-submission reviewers.

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MYCOTAXON

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ASCOSPHAERA TENAX SPECIES NOVA AND A VARIANT OF *ASCOSPHAERA AGGREGATA*

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SUMMARY

Ascosphaera tenax sp. nov. with tough and leathery spore cysts is described. The fungus was found feeding saprophytically in association with *Megachile willughbiella*. Further, some atypical chalkbrood symptoms on *M. rotundata* larvae are found to be caused by a variant of *A. aggregata*.

INTRODUCTION

Eighteen years ago, nesting cells of the leafcutter bee *Megachile willughbiella* Kirby were collected from a rotten door rail at Søllested, Lolland (Holm & Skou, 1972), and infection with *Microascus exsertus* Skou (≡ *Pithoascus exsertus* (Skou) v. Arx, 1973) (Skou, 1973) was found during experimental rearing of the bees. Nesting cells of *M. willughbiella* with *M. exsertus* were found again in October 1984 in a rotten garden seat at Lindenborg, Zealand and in August 1985 in a dry-rotten tree stump at Nekselø (a small island close to the northwestern coast of Zealand). At these sites, an undescribed *Ascosphaera* species was found together with *M. exsertus* (Fig. 1a) (Skou, 1986).

Further, Nørgaard Holm received in March 1987 and in February 1988 collections of dead larvae of the alfalfa leafcutter bee *M. rotundata* (Fabr.) from J. Jakobsen, Tilley, Alberta, Canada, who had obtained the collections from "The Cocoon Testing Laboratory" in Brooks, Alberta, Canada. The larvae were sorted in boxes in regard to their symptoms. J. Jakobsen, Alterba, and Professor W.P. Stephen, Oregon (pers. comms), have recorded mortalities as high as 17% and 30%, respectively, due to chalkbrood diseases in populations of *M. rotundata* in southern Alberta. However, these diseases seem to be uncommon in the leafcutter bee populations of the bee producers in general according to Richards (1985) and Fairey & Lieverse (1987).

The results of examination of these collections are presented below.

MATERIALS AND METHODS

The material examined comprised a small sample of *Megachile willughbiella* Kirby cocoons from Lindenborg (1984) and a larger one from Nekselø (1985) infected with an undescribed *Ascosphera* species. Further, two collections of hundreds of dead larvae of the alfalfa leafcutter bee *M. rotundata* (Fabr.) were obtained from "The Cocoon Testing Laboratory", Brooks, Alberta, Canada, by J. Jakobsen (1987, 1988). *M. rotundata* larvae from the Department of Crop Science, Tåstrup, were used for an infection test with spores from the Canadian larvae.

A small test was set up using *M. rotundata* larvae reared on sterilized pollen diet (Nelson et al., 1972) with aureomycin. Ca. 100 mg diet was placed in each of 30 microwells (γ-ray sterilized Nunclon Delta SI box with 8 x 12 microwells). Spore cysts from the Canadian larvae were separated after removal of the larval skin, crushed and mixed with 1 ml of the diet. A drop of the resulting spore suspension was placed on top of the diet in each of 25 of the microwells. An egg or a newly hatched larva was transferred unsterilized to all 30 microwells.

Test for growth of the fungi were made on common media and on the special sugar rich media used for species of *Ascosphaera* (Skou, 1988).

The measurements were made with an ocular screw micrometer.

RESULTS

Ascosphaera tenax Skou *et* Holm sp. nov.

Etymology: 'tenax' = tough. This epithet refers to the inner membrane of the spore cysts which are tough and leathery as opposed the vitreous fragile consistency of the inner membrane in the other described species.

Descriptio: *Sporocystae nigrae vel brunneae, globosae, 33 - 67 - 105 µm magnae, 86 pro 100 inter 40 et 90 µm. Membrana externa hyalina, gelatinosa, sine colore et membrana interna translucenti brunnea, levis, tenax et coriacea, 1.5 µm crassa. Globuli sporarum sphaerici, 7.7 - 11.9 - 15.4 µm magni, 89.5 pro 100 inter 9.0 et 14.0 µm. Ascosporae unicellulares, naviculares vel subfalcatae et diametienti parum triangulatae, 0.6 - 0.7 - 0.9 x 1.9 - 2.7 - 3.5 µm magnae; ratione longitudinis pro latitudine ita 3.9. Status anamorphosis non observatus.*

Habitat in chrysalibus, cibaria et faecibus Megachilis willughbiellae Kirby *et Megachilis rotundatae* (Fabr.).

Holotypus anno 1985 in chrysalibus Megachilis willughbiellae in insula Nekselø, Dania lectus, in Museo et Herbario Hauniensi (C) depositus.

Description: The spore cysts are lustrous black or infrequently dark brown, globose, 33 - 67 - 105 µm with 86% between 40 and 90 µm (Fig. 1b). The outer membrane hyaline, gelatinous and colourless. The inner membrane dark brown in translucent light, smooth, tough and leathery, 1.5 µm thick and structureless in fraction (Fig. 1e and 1f). Spore balls globose, 7.7 - 11.9 - 15.4 µm with 89.5% between 9.0 and 14.0 µm (Fig. 1c). Ascospores one-celled, boat-shaped or sub-falciform when seen from the side, tending to be triangular in cross section - almost like a piece of orange, 0.6 - 0.7 - 0.9 x 1.9 - 2.7 - 3.5 µm with little variation (Fig. 1d and 1e). Length-to-width ratio: 3.9. Anamorph state not observed.

Habitat in cocoons, provisions and faecal pellets of *Megachile willughbiella* and *M. rotundata*.

Holotype in cocoons of *Megachile willughbiella* from Nekselø island, Denmark 1985 is deposited in the Botanical Museum and Herbarium, Copenhagen, Denmark (C).

Materials examined: Leaf cells with cocoons of *M. willughbiella* were collected from excavated tunnels in a rotten garden seat at Lindenborg and a dry-rotten tree stump at Nekselø. A number of cocoons from these sites were examined (Tab. 1).

Table 1. Distribution of fungi in cocoons of *Megachile willughbiella* from Nekselø (40) and Lindenborg (4)*.

Number of cocoons	*Ascosphaera tenax*	*Microascus exsertus*	*Eurotium* sp. (*Aspergillus* sp.)
5	+		
11	+	+	
1	+	+	+
26		+	
1	+		+
44	18	38	2

* Further, three cocoons with dead bees and two empty cocoons were without fungi.

Further, *A. tenax* was found in a few cases in cocoons of *M. rotundata* in the summer of 1988 at the Department of Crop Science, Tåstrup.

It seems characteristic that some unbroken spore cysts are empty. The pressure necessary in order to open the tough and leathery spore cysts may crush the spore balls or make them flatten out as the spores are kept together by a mucous substance.

A. tenax was found feeding saprophytically in cocoons with living larvae or infrequently on dead larvae where they most likely just grow *post mortem*. It seems more likely that *M. exsertus* may have killed the larvae.

The mycelium is intermingled with the rough silky web of the cocoons where there also are many spore cysts. Spore cysts now and then form a whole tapestry on the inner side of the cocoons, obviously without doing any harm to the larva inside. Fewer spore cysts occur on the outside of the cocoons but they are common on the pollen and faecal pellets beneath the inside of the leaf cap.

Hitherto, no growth on artificial media.

The Canadian collections

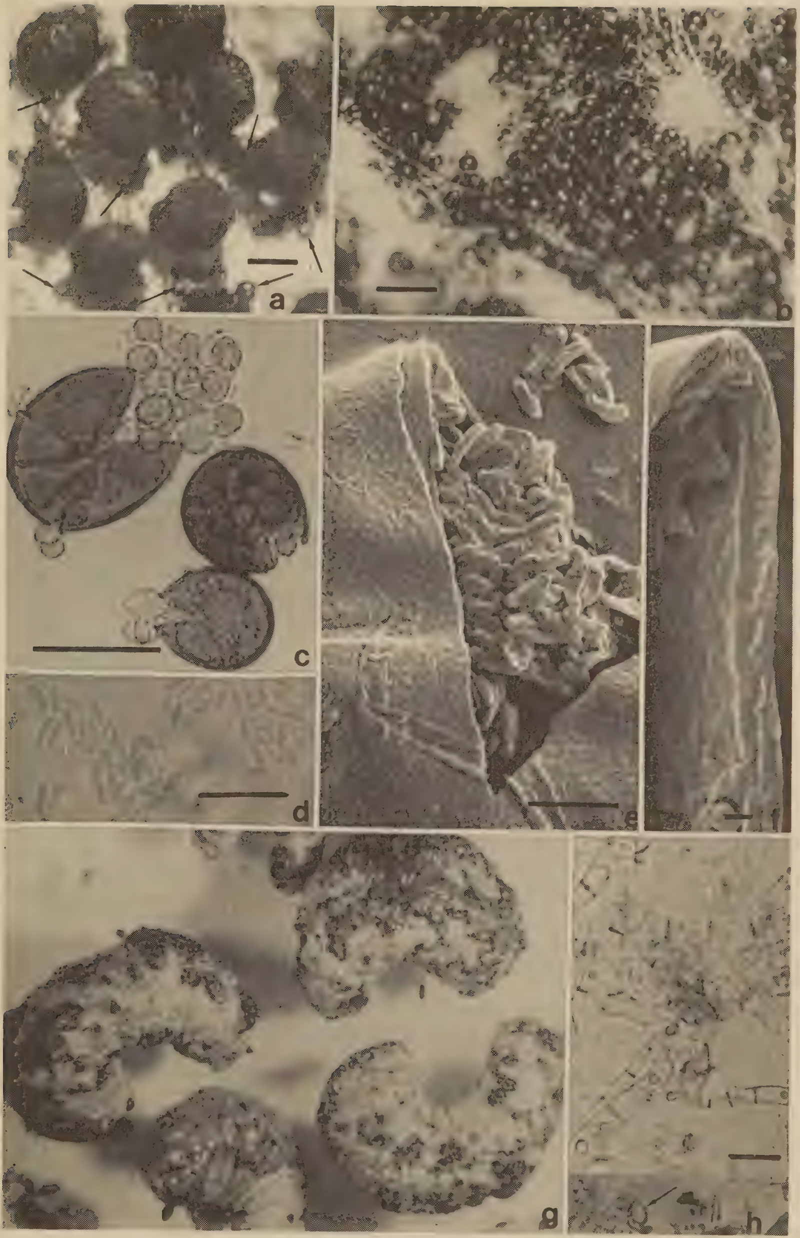
The larvae of *M. rotundata* from the two Canadian collections may be separated in four categories on the basis of their symptoms. The larvae vary in size but most of those in the first three categories are considered to be in the last instar whereas many of those in the fourth category are dead at an earlier state of development:

Category 1. Larvae with the ragged appearence of attack with *A. aggregata* Skou due to rupture of the brittle cellophane-like skin covering the closely aggregated black spore cysts all over the body (Skou, 1975; Fairey et al., 1985). All the spore cysts are filled with spores resulting in an enormous spore production from each dead larva.

Category 2. Beige to tan larvae with small and larger black boils caused by groups of spore cysts (Fig. 1g). The larval skin over these boils may or may not be cellophane-like. Most of the spore cysts appear angular in cross section and are conical like those of the first category but contrary to them, they are easily separable and have one or more depressions caused by pressure from the adjacent spore cysts. Most of the spore cysts with depressions are empty or almost empty for which reason the spore production with this type of attack is much less than in the case of the common attack with *A. aggregata*.

A small infection test was set up as described under Material and Methods. The symptoms described above developed on five of the 25 larvae in the microwells with diet infested with spores from category 2 larvae and none devel-

Figure 1a-f. *Ascosphaera tenax*. **a**: Spore cysts between perithecia of *Microascus exsertus* (arrows pointing on examples), x 35 bar = 200 µm. **b**: Spore cysts on pollen, x 45 bar = 200 µm. **c**: Broken spore cyst with spore balls, x 350 bar = 50 µm. **d**: Ascospores, x 1250 bar = 10 µm. **e**: SEM micrograph of a broken spore cyst, x 2500 bar = 5 µm. Note the two wall membranes with the tough and leathery appearence and the boat-shaped, triangular ascospores. **f**: SEM micrograph of the 1.5 µm thick inner membrane, x 4000 bar = 1 µm. **g**: Larvae of *Megachile rotundata* with boils caused by the variant of *Ascosphaera aggregata*, x 7. **h**: Non-sporulating *Ascosphaera*-mycelium from a larva of *M. rotundata*, x 300 bar = 25 µm. Note the conspicuous septa that persist after colapse of the mycelium - often as a ring, see arrow.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oped the common symptoms of attack with *A. aggregata*. *A. atra* Skou & Hackett developed on the diet in one well and some of the other wells were overgrown with yeast.

Comparison of the size of the ascospores from this test and the Canadian collection from 1988 with that of *A. aggregata* showed no significant difference whereas the comparison showed that a part of the Canadian collection from 1987 had ascospores with a somewhat larger diameter.

Larvae with this variant of *A. aggregata* are deposited at the Botanical Museum and Herbarium, Copenhagen (C).

Catagory 3. Beige to brown larvae without any spore cysts. An examination showed that they are filled with mycelium with the characteristic very conspicuous persistent septa of most of the *Ascosphaera* species (Fig. 1h) (Skou, 1988).

Category 4. Black or almost black larvae - a colour that is often obtained by larvae dead for various reasons. Many of these larvae appear sticky as if they have been immersed in a semi-liquid provision. Little mycelium was found with the microscopic examination of these larvae. When mycelium was present, it did not clearly show the *Ascosphaera*-type of septa and surface sterilized cut larvae plated on agar medium gave only *Aspergillus, Penicillium, Rhizopus* and yeast species (cf. Richards, 1985).

DISCUSSION

There is no direct contact between the sites of collection as Lindenborg and Nekselø lay 103 and 110 km apart, respectively, from the site of origin (Søllested, Lolland) of *M. exsertus* (Skou, 1973), and about one third of this is across the sea. Further, the distance between these two sites is 43 km. This might indicate that the fungi frequently occur in association with *M. willughbiella*. Besides, it was ascertained that the bees have nested in the dry-rotten tree stump for years, where *A. tenax* and *M. exsertus* have had good possibilities to accumulate.

It is clear that *A. tenax* grow on pollen and faecal pellets but the intermingling of mycelium and cocoon web, and the large number of spore cysts on the inside of the cocoon - obviously without affecting the bee larva - is hard to understand unless the fungus thrive also on the probably proteinaceous web of the cocoon.

One may wonder how the well protected spores come out of the leathery spore cysts. They may come out and spread when the bee make its way out of the cocoon.

The symptoms described for category 2 of the Canadian collections seem not to have been mentioned in the literature unless it is the "mottled appearence" and "mottled cream and black" mentioned by Vandenberg & Stephen (1982) and Richards (1985), respectively. It may be that these symptoms also occur on a figure in the paper of Stephen & Undurraga (1978, Fig. 1).

The small infection test made by us only indicate that the symptoms on the larvae and the appearence of the fungus may be reproduced. More investigations are necessary to clarify if it may be a special strain or a variety of *A. aggregata* in question or if the reason may be something else.

It is common to find a few empty spore cysts in *Ascosphaera* species in nature, but we have never seen anything like that occurring in category 2 of the Canadian collections.

The occurrence of spore cysts with somewhat thicker spores in the Canadian 1987-collection is in accordance with that found in another Canadian collection (Youssef et al., 1985). It might be a question of young spores as proposed by Liu (1987) for *A. apis* (Maassen & Claussen) Olive & Spiltoir but the spores cannot lie about and later unite into spore balls as he asserted. The spores are from the beginning joined together and surrounded by an evanescent membrane (cf. McManus & Youssef, 1984; Skou, 1988) and not without an apparent membrane as maintained by Richards (1985) and Liu (1987).

As noted by Richards (1985), it is inadequate to diagnose different *Ascosphaera* species on the mycelial growth or hyphal characteristics but the conspicuous persistent septa make their mycelia different from that of many other fungi (Fig. 1h) (Skou, 1988).

A. atra, that occurred in the infection test, most likely have been carried along with the Canadian collections (cf. Richards, 1985) though this species is found also in Denmark.

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SCUTELLOSPORA BIORNATA: A NEW SPECIES IN THE ENDOGONACEAE FROM THE LLANOS ORIENTALES OF COLOMBIA

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SUMMARY

Scutellospora biornata, a mycorrhizal fungus, was isolated from associations with native grasses. Two ornamented walls distinguish it from other species in the genus. Novelties related to the germination shield are discussed as well as the deformation of the laminated wall caused by common mountants.

RESUMEN

Scutellospora biornata, un hongo micorrizógeno que fué encontrado en asociación con gramíneas, tiene esporas con dos paredes ornamentadas que lo distingue de otras especies del género. En la descripción se incluyen aspectos nuevos relacionados con el escudo germinativo. También se discute la deformación de la pared laminada de las esporas en medios de montaje.

INTRODUCTION

Spores from vesicular-arbuscular mycorrhizal associations with native grasses were isolated over a period of years at the Centro Nacional de Investigaciones Agropecuarias (ICA-CIAT) at Carimagua, Meta. Several new species were previously described from this location (Schenck et al., 1984; Schenck et al., 1986). A Scutellospora species having two ornamented walls is described in this paper.

Refer to Spain et al. (1989), for the use of the terms sporogenous cell and sporophore.

DESCRIPTION

Scutellospora *biornata* Spain, Sieverding & Toro sp. nov. Figures 1-3.

Sporae singillatim in solo ennatae, globosae, (120-) 260-450 (-493) µm diam., flavae vel badiae. Paries sporae e stratis quinque vel sex (primum ad sextum) congregatis in turmis duobus. Turma externa cum stratis tribus (primum ad tertium): stratum primum brunneolo-flavum, solidum, 0.5-1 µm crassum cum ornamentatione e papillis rotundatis (0.5-) 1-3 µm diam. usque ad 2 µm longis; stratum secundum hyalinum lamellatum, (5-) 6-10 µm crassum; stratum tertium membranosum, hyalinum, 0.5-1 µm, cum ornamentatione simile strati primi. Turma interna hyalina cum stratis duobus vel tribus (quartum ad sextum). Stratum quartum membranosum, <0.5 µm crassum, saepe absens; stratum quintum membranosum, <0.5-1 µm crassum; sextum solidum, 1-2 µm crassum. Stratum secundum in solutione cum lactophenolio tumescens. In solutione Melzeri, stratum secundum purpureum colorans, stratum sextum pallide ruber. Cellula sporogenea fusca, (30-) 50-60 (-65) µm diam. Cellulae auxiliares generatim napiformes in fasciculo; cellula auxiliaris cum nudis. Germinatio sporae propria generis: plicatum spatium fuscum, inter stratum quintum et sextum efformatum, (113-) 188-238 X (113-) 188-275 µm diam. Usque ad 20 loci tuborum germinalerum, separati inter se per fissuras nigro-brunneas.

SPORES: borne singly in soil; globose, (120)260-450(-493) µm diam. or sub-globose 282-384 X 341-415 µm (measured in water); translucent, yellowish-brown to brown.

SPORE WALL STRUCTURE (spores ruptured and measured in water, Figs. 1A-E; 2): 6 walls, 8-15 µm thick, in two groups. Group A, 6-12 µm thick, of 3 walls: wall 1 unit wall, 0.5-1 µm thick, brown, ornamented on outer surface with noncontiguous blunt tapering projections from (0.5-)1-3 µm diam. at base up to 2 µm long, fused to wall 2. Wall 2 hyaline to sub-hyaline (up to 15 laminae), (5-)6-10 µm thick, adherent to wall 3. Wall 3, hyaline, membranous, 0.5-1.0 µm thick, ornamented on inside with blunt projections, 0.5-1 µm diam. to 2.0 µm long, generally smaller and more dense than projections on wall 1. Group B, 2-3 µm thick, of hyaline walls 4,5 & 6. Wall 4 membranous, <0.5 µm thick, rarely present; wall 5, membranous <0.5-1 µm thick, less elastic than adherent pliable unit wall 6, 1-2 µm thick.

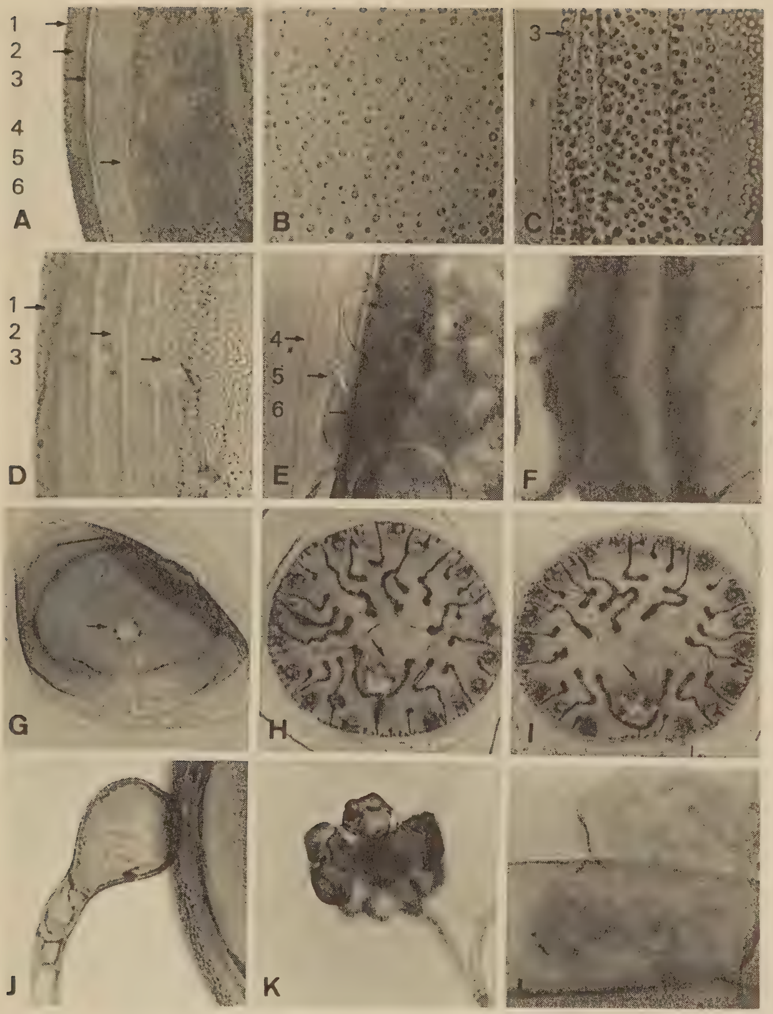
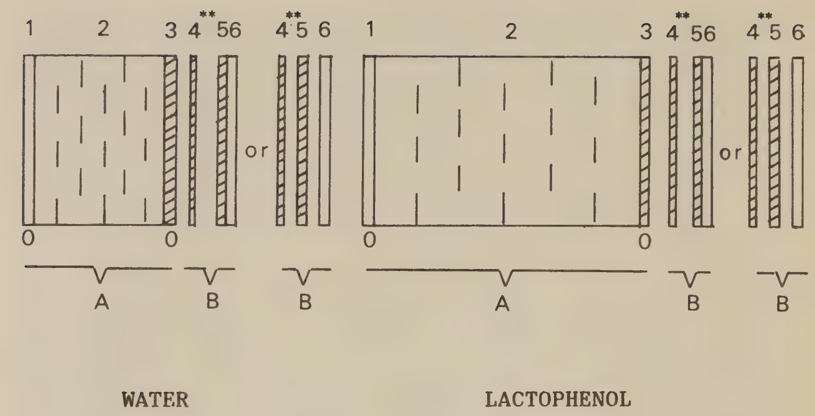


Figure 1. Scutellospora biornata. A) Wall groups A (1-3) & B (4-6) in water 200X. B) Wall 1 ornamentation, 1000X. C) Wall 3 ornamentation 1000X. D) Group A (1-3) in lactophenol; laminated wall 2 grossly expanded, 400X. E) Group B (4-6), Melzer's reagent, 1000X. F) Remnant on wall 6 of connection with sporogenous cell, 1000X. G) Aperture in wall 6 for formation of germination shield, Melzer's reagent, 200X. H) Germination shield: 'Y' configuration around aperture, 400X. I) Germination shield: 'U' configuration around aperture, 400X. J) Sporogenous cell of sporophore, 200X. K) Knobby auxiliary cells, 400X. L) Arbuscule in cortical cell of Puereria phaseoloides, 1000X.



** Rarely present

Figure 2. Murographs of Scutellospora biornata spores in water and lactophenol. Six walls in two groups: walls 1 & 3, group A, ornamented; wall 4**, group B, rarely present. Laminated wall 2, group A, deformed by reaction to lactophenol.

REACTION TO MOUNTANTS AND MELZER'S REAGENT: laminated wall 2, group A, is strongly reactive (swelling) to lactophenol (Figs. 1D; 2) and PVL and turns reddish-purple in Melzer's reagent. Walls 4, 5 & 6, group B, can separate in lactophenol and Melzer's reagent (Figs. 1E; 2); wall 6 turns light to deep pink.

GERMINATION SHIELD (Figs. 1G-I; 3): brown, (113-)188-238 X (113-)188-275 µm, cresent shape in x-section, formed between walls 5 and 6. A spore generally has one shield although two can form. Multiple apertures in wall 6 may be present (internal or external to the developed shield). Greatest pigment concentration around germ tube initials, aperture, Y & U configurations and other fissures. Germ tube initials, numbering (6)12-20 ($\bar{x}$ 17), 6-7 µm diam., generally separated from each other by a long fissure.

GERMINATION TUBE, light brown, coenocytic, 15-20 µm diam. proximate to shield narrowing to 9-14 µm diam., wall 1-1.5 µm thick. A single germ tube usually emerges at germination.

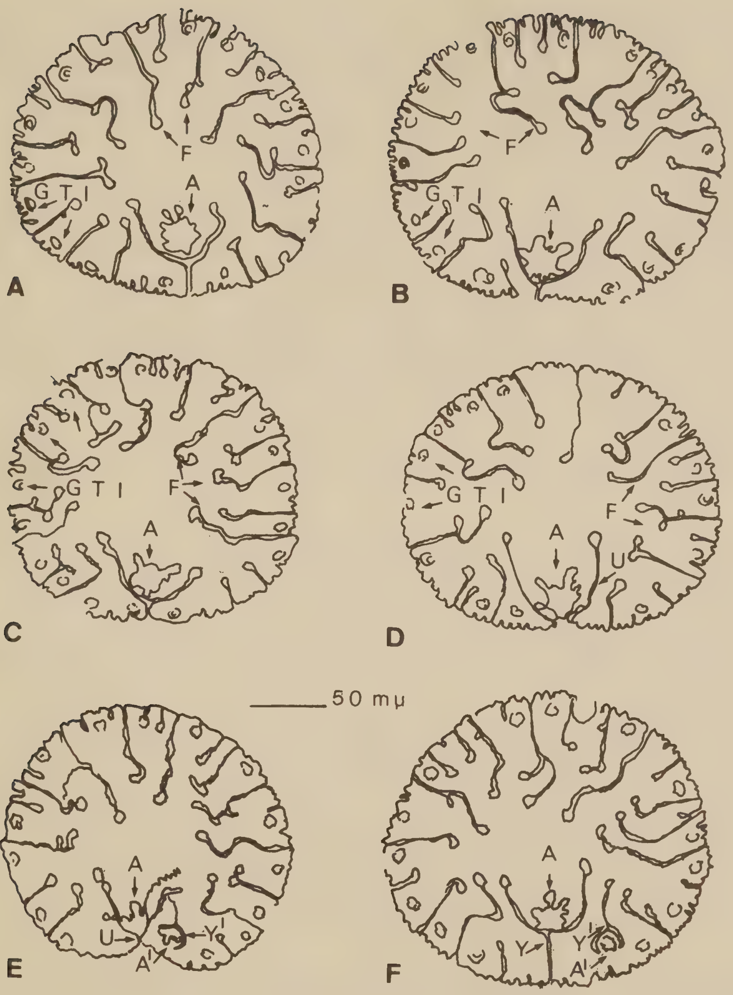

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Figure 3. *Scutellospora biornata* germination shields, plan view (camera lucida drawings). A-F) Germ tube initials (GTI) generally separated by long fissures (F). A-C & F) 'Y' (Y) configuration around aperture (A). D & E) 'U' (U) configuration around aperture (A). E & F) Aborted shield with a small aperture (A') and rudimental 'Y' (Y') configuration within developed shield.

SPOROGENOUS CELL: apical cell of the sporophore, brown, (30-)50-60(-65) µm diam.; 1-3 walls totalling 2-4 µm thick; spore initial site generally apical (Fig. 1J); hyphal branches (pegs) may be present. Projections, somewhat larger than the ornamentation on the outer surface of the spore, may be present on the innermost wall.

SPOROPHORE: brown, septate below the sporogenous cell (Fig. 1J), 15-28 µm diam. narrowing to (7.5-) 10-13 µm in diam. with 1-2 walls up to 2.5 µm thick. Hyphal branches may form below the sporogenous cell.

AUXILIARY CELLS: brown, knobby and generally napiform, 32-48 X 37-48 µm diam., formed in clusters of 10-20 on coiled, thin walled, <1 µm thick, coenocytic hypha 3-5(-8.75) µm diam. (Fig. 1K).

ARBUSCULES and coiled hyphae form in cortical cells of infected roots (Fig. 1L).

TYPE: Colombia, Cali, Centro Internacional de Agricultura Tropical (CIAT), pot culture C-9; holotype GOET; isotypes COL, FLAS, OSC. Viable spores deposited in INVAM.

ETYMOLOGY: *biornata*, Latin, referring to the two ornamented spore walls.

DISTRIBUTION: *Scutellospora biornata* was first recovered from a sward of native grasses growing in a loamy sand at Hato Alegria, Carimagua, Meta, in the Llanos of Colombia. The soils, Oxisols with pH 4.8, have the following textural and chemical characteristics: sand 68%, silt 23%, clay 9%; exchangeable cations expressed in meq/100 g: Al 0.8, Ca 0.12, Mg 0.06. K 0.04; Al sat'n 82%; P 2.1 mg/kg soil (Bray II) and S 17 mg/kg soil.

MYCORRHIZAL ASSOCIATIONS KNOWN: *Andropogon gayanus* Kunth, *Brachiaria decumbens* Stapf, *Manihot esculenta* Crantz, *Pueraria phaseoloides* Benth & *Zea mays* L. and unidentified native grasses.

DISCUSSION

Scutellospora biornata spores can be readily separated from other pigmented *Scutellospora* species with ornamentation by the presence of a second ornamented wall.

Wall features of some spores in the Endogonaceae can be modified significantly by mountants and fixatives (Morton, 1986). Sward (1981) and others have recognized the need for a fixative and/or mountant which will preserve the integrity of the walls; that need is particularly evident with this spore. Lactophenol and PVL cause gross swelling (to a thickness of 55 µm) of laminated wall 2 (Figs. 1D; 2); apparently phenol is the reactive substance (Morton, 1986). Some or all of the laminae become diaphanous having little, if any, discernible structure; small rod-shape refractive areas are present in the distended wall. The laminae separate slightly at the rupture site in water, however, the wall character is not visibly altered. There was no distension of the laminated wall of spores fixed in FAA and mounted in lactophenol. The reaction time of the laminated wall (wall 2, group A) to Melzer's reagent is delayed. The reaction begins at the rupture sites and progresses slowly due to the non-reactive, tightly adherent, walls 1 and 3.

Wall 1 is fused to the adjacent laminae; observations of developing spores indicate that the initially smooth, subhyaline wall 1, continuous with the outer wall of the sporogenous cell, becomes ornamented and pigmented; areas, generally small, free of any ornamentation can occur. Wall 4, an extremely thin membranous wall in group B, observed in water, lactophenol and Melzer's, is rarely present. Walls 5 & 6 have the appearence of a coriaceous wall, a single wall wrinkled externally (Walker, 1986). Wall 5, less elastic than wall 6, wrinkles as it adheres somewhat loosly when the wall group is ruptured; occasionally walls 5 & 6 partially separate in water. Alhough pliable, wall 6, which readily ruptures but does not collapse, is described as a unit wall. A remnant of the connection to the sporogenous cell has been observed on wall 6 (Fig. 1F).

Walker & Sanders (1986) indicated that germination shields may have taxonomic value at the species level. The germination shield of S. biornata is complex compared to the simple shields of S. heterogama and S. calospora and is formed between walls 5 & 6 of group B, rather than being constrained by the inner and outer wall groups as described by Walker and Sanders (1986). It may develop near the sporogenous cell or be unrelated to it. Usually a single aperture develops in wall 6; cytoplasm, apparently confined by the plasmalemma, is extruded through the aperture which appears as a tear having a very irregular periphery (Figs. 1G; 3A-F); pigment is concentrated around the perimeter. Fissures form a 'U' (Figs. 1I; 3D, E) around the aperture when the shield develops in such a way that the aperture is on the perimeter; shields thus formed are generally less round on the side of the aperture. Fissures form a 'Y' (Figs. 1H; 3A-C, F) when the aperture is sub-marginal to the developed shield. The 'U' and the 'Y' configurations occur with similar frequency. The germ tube initials are generally separated from each other by a long fissure. One or two medium long and numerous short fissures are usually present within these divisions. The mode of development of the fissures is not understood. Walker and Sanders (1986) infer that the "wishbone ('Y') formation occurs when the "...extruding membrane folds back on itself." Until ruptured by an emerging germ tube, the numerous germ tube initials are covered by the outermost ornamented wall. Walls 5 & 6 become rigid and inseparable from the shield; the rigidity and occasionally some pigment may extend slightly beyond the shield.

Two shields of average size have been observed within a single spore; they may overlap slightly or be completely separate. Multiple (up to six have been observed) small apertures, internal and/or external to the shield, may develop in addition to the large aperture. Shield development can be aborted; occasionally a small aperture has a rudimental 'Y' configuration formed around it (Fig. 3E & F); more often there is no evidence that cytoplasm was extruded through the small apertures.

Rare sporophore novelties pertain to the sporogenous cell. One sporogenous cell was bifurcate with no spore development; two sporogenous cells had an attached developed spore and an incipient spore.

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TYPE STUDIES IN THE POLYPORACEAE - 21. SPECIES DESCRIBED BY C.G. LLOYD IN **CYCLOMYCES, DAEDALEA, FAVOLUS, FOMES** AND **HEXAGONIA**

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ABSTRACT. 94 species described by C.G. Lloyd in **Cyclomyces, Daedalea, Favolus, Fomes** and **Hexagonia** have been reviewed and the type specimens examined. 75 names are synonyms of existing names, 13 are accepted, the types for 3 names are sterile and three types are lost. 4 species are described and the following new combinations are proposed: **Ganoderma sculpturatum, Perenniporia malvena, Phellinus pusillus, Phellinus sublamaensis** and **Trametes sinensis.**

KEYWORDS. Basidiomycetes, Polyporaceae, C.G. Lloyd.

INTRODUCTION. C. G. Lloyd was an eccentric businessman with an avid interest in mycology. He published a long series of Mycological Notes which later was bound in 7 volumes. The pagination of the volumes is erratic, of driving unaware librarians against the wall.

After his death, his collection with all types was given to the Smithsonian Institution which later transferred it to the National Fungus Collection in Beltsville, Maryland (BPI). Lloyd described an incredible number of new species in many groups and Stevenson and Cash (1936) have published an Index to all his new names and combinations. In the Index there are references to place of publication, Lloyd collection number and all pertinent data concerning the types. To save space, this information is not repeated here although the country from where the species was described is given after an abbreviated reference to where the name was published. L.M.W. means Lloyd Mycological writings and the next digit refers to the volume of the bound version followed with a reference to the pertinent page and year.

In this paper the species are treated in the same way as in the Stevenson and Cash Index, i.e. alphabetically according to specific epithet within each genus in which they originally were described.

This paper is the first in a series treating Lloyd`s polypores. The remaining species will be treated similarly in separate papers.

When a species is accepted taxonomically, it is cited in the appropriate genus with a reference to a recent description, or the species is described if no modern description seems to exist.

CYCLOMYCES
albida, C. L.M.W. 6:1007, 1920. Philippine Islands.
= Lenzites vespacea (Pers.) Ryv.
isabellina, C. L.M.W. 7:1270, 1924. Philippine Islands.
= Lenzites stereoides (Fr.) Ryv.

DAEDALEA
boseii, D. L.M.W. 7:1109, 1922. India.
= Lenzites acuta Berk.
fuscospora, D. Lloyd in Van der Byl. S. Afr. J. Sci. 21:308,1924.Zimbabwe.
= Inonotus ochroporus (Van der Byl) Pegler
There is a detailed description in Reid (1973:147-48), where he suggests that the type may represent an Inonotus species. I. ochroporus does have setae, but they often are very difficult to observe (see Ryvarden & Johansen 1980:125) and that may be why they were not observed by Reid nor in the tiny fragment which was at my disposal. I have collected I. ochroporus at Victoria Falls, Zambia/Zimbabwe, the type locality of Lloyds species. The macromorphology with the duplex consistency of the context, the hyphal system and the spores are all identical in the two species. Until a new convincing collection has been made of Lloyds setae-less species, it is treated as stated above.
fusco-stratosa, D. L.M.W. 7:1270, 1924.Brazil.
= Daedalea sprucei Berk.
glabra, D. L.M.W. 7:1270, 1924.Philippine Islands.
= Lenzites acuta Berk.
maculata, D. L.M.W. 7:1155,1922 Philippine Islands.
= Lenzites stereoides (Fr.) Ryv. as suggested by Lloyd.
mollicula, D. L.M.W. 7:1146, 1922. Japan.
= Trametes elegans (Spreng.:Fr.) Fr.
reflexa, D. L.M.W. 7:1155, 1922.Philippine Islands.
= Accepted in Daedalea.
Basidiocarp pileate, 4 cm wide and long, upper surface coarsely fibrous ochraceous to pale cinnamon brown, hymenophore poroid to labyrinthine, 1-3 pores per mm, cinnamon brown, tubes up to 3 mm deep, context cinnamon, 1 mm thick, no cuticle on pileus.
Hyphal system dimitic. Generative hyphae hyaline, 2-3 um wide and with clamps , skeletal hyphae abundant, pale yellowish to pale brown, thick-walled, 3-6 um wide, pointing into the hymenium as a distinct catahymenium, basidia and spores not seen.
Although the type is sterile, and the type of rot are not known, the species should be easy to recognize in the field because of the fibrous to partly shredded upper surface and the irregular hymenophore. Daedalea may not be the best genus when a fertile collection is found and the rot is known, but for the time being, Lloyds original disposition is accepted.
ridleyi, D. L.M.W. 6:930, 1920. Singapore.
= Lenzites acuta Berk.The type is sterile and seemingly treated with some chemical making it much darker than normally seen in this species.
roseola, D. L.M.W. 7:1145, 1922.Malaysia.

= Trametes elegans (Spreng.:Fr.) Fr.
sinensis, D. L.M.W. 7:1112, 1922.China.
=**Trametes sinensis** (Lloyd) Ryv. comb. nov. Basionym as cited above. This is a prior name for Trametes radiata Burt 1932, also described from China.

Basidiocarp pileate, applanate to triquetrous, woody when dry, up to 8 cm long and 4 cm wide and up to 3 cm thick at the base, upper surface at first finely velutinate, soon glabrous and with age tuberculate to irregularly warted, azonate, pale ochraceous to pale grey, pore surface white to pale cream, pores angular, thin- walled, 1-2 per mm, dentate in the dissepiments like in some American forms of Piptoporus betulinus (Fr.) Karst.,tubes up to 2,5 cm deep, concolorous with pore surface, context dense, cream to pale olivaceous grey, radially zonate, up to 0,5 cm thick at the base.

Hyphal system trimitic, generative hyphae with clamps, 2-4 um wide. skeletal hyphae abundant, hyaline, thick-walled to almost solid, 3-6 um wide, binding hyphae solid, hyaline tortuous, 3-4 um wide, basidia clavate, only seen sterile,15-20um long, basidiospores not seen.

Specimens only seen from China. Trametes ljubarskyii, Pil. described from Vladivostok is rather similar, but easily separated by smaller and round pores (3-4 per mm).(For a description of this species, see David 1966). Trametes lactinea Berk. known from tropical Asia has a matted velutinate and even surface and more rounded pores. Spore prints and cultural work is desirable in this group of species to settle their true relationship.

Trametes sinensis is easy to recognize in the field because of the angular dentate pores and the cream to pale ochraceous glabrous upper surface with distinct warts and scrupose tuberances. Its triquetrous shape seems also to be a constant feature.

stratosa, D. L.M.W. 7:1147, 1922.Brazil.
= Daedalea actinophila (Mont.) Rajchenb.
umbrina, D. L.M.W. 4:10, 1914. Brazil.
= Daedalea sprucei Berk.
ungulata, D. L.M.W. 4(60):15, 1915. Japan.
= Gloeophyllum sepiarium (Fr.) Karst.

FAVOLUS

africanus, F. L.M.W. 7:1194, 1923. Uganda.
= The type has not been found.
bengala, F. L.M.W. 7:1147, 1922.India.
= cfr. Trametes sp, but the type is sterile and no formal transfer is proposed. Basidiocarp dimidiate, 3 cm long and 2 cm wide, upper surface smooth and glabrous, pale dirty gray and faintly zonate,pore surface pale grey, pores angular, 1-1,5 mm in diameter, tubes up to 5 mm deep, concolorous, context thin and pale ochraceous.

Hyphal system trimitic, generative hyphae hyaline, 2-3 um wide and with clamps, skeletal hyphae hyaline, solid. 3-4 um wide, binding hyphae solid, tortuous,2-3 um wide, basidia and spores not seen.

Superficially, this species looks like Trametes bresadolae

Ryv. (for a description, see Ryvarden 1988:313) but this species has a distinct duplex consistency. A fertile collection and knowledge about the rot are necessary to settle the position of this species. Indian mycologists should be aware of it.
caespitosus, F. L.M.W. 5:821, 1919. USA.
= Polyporus tenuiculus (Beauv.) Fr. as already suggested by Lloyd.
dussii, F. L.M.W. 7:1194, 1923. Guadeloupe.
= Trametes villosa (Fr.) Kreisel
glandulosus, F. L.M.W. 7:1156, 1922. Philippine Islands.
= Polyporus philippinensis Berk.
grammocephalus, F. L.M.W. 7:1271, 1924. Fiji.
= Polyporus philippinensis Berk.
kauffmanii, F. L.M.W. 5:614, 1916.USA.
= Polyporus alveolaris (DC.:Fr.) Bond. & Sing.
lagunae, F. L.M.W. 7:1157, 1922.Philippine Islands.
= Polyporus philippinensis Berk.
leeuwenii, F. L.M.W. 6:1079, 1921.Indonesia.
= Echinochaete brachyporus (Mont.) Ryv.
lutescens, F. L.M.W. 7:1272, 1924.Honduras.
= Polyporus tenuiculus (Beauv.) Fr.
mollis, F. L.M.W. 7:1330, 1924.Brazil.
= Polyporus tenuiculus (Beauv.) Fr.
parviporus, F. L.M.W. 7:1146, 1922.Ecuador.
= The type is lost.
peponinus, F. L.M.W. 5(66):16, 1917.USA.
= Polyporus alveolaris (DC.:Fr.) Bond. & Sing.
roseus, F. L.M.W. 7:1157, 1922. Singapore.
= Polyporus tenuiculus (Beauv.) Fr.
samoensis, F. L.M.W. 7:1194, 1923. Samoa.
= Polyporus philippinensis Berk.
scabro-lineatus, F. L.M.W. 7:1157, 1922.Philippine Islands.
= Polyporus philippinensis Berk.
trigonus, F. L.M.W. 7:1332, 1924. Brazil.
= Polyporus craterellus Berk. & Curt.
whetstonei, F. L.M.W. 5:615, 1916. USA.
= Polyporus alveolaris (DC.:Fr.) Bond. & Sing.

FOMES

agglutinatus, F. L.M.W. 7:1156, 1922.Philippine Islands.
= Loweporus fusco-purpureus (Pers.) Ryv.
albotextus, F. L.M.W. 7:1332, 1924. South Africa.
= **Ischnoderma albo-textus** (Lloyd) Reid
For a description, see Reid 1974: 225.
angularis, F. L.M.W. 4:586, 1915.Japan.
= Phellinus sp. sterile.
annularis, F. L.M.W. 4(40):6, 1912.South Africa.
= Ganoderma australe (Fr.) Pat.
borealis, F. L.M.W. 4:247, 1915. Canada.
= Phellinus igniarius (L.:Fr.) Quél.
clelandii, F. L.M.W. 4(60):11, 1915.Australia.
= **Perenniporia clelandii** (Lloyd) Ryv.
For a description, see Cunningham 1965:145.
cuneatus, F. L.M.W. 4:217, 1915. Australia.
= Australoporus tasmanicus (Berk.) Buchanan & Ryv.

densus, F. L.M.W. 4:245, 1915.France.
= Phellinus conchatus (Pers.:Fr.) Quél. according to Lloyd in the description. The type is lost.
durissimus, F. L.M.W. 6:943, 1920.Angola.
= Phellinus fastuosus (Lév.) Ryv.
gilvus, F. L.M.W. 4(42):6, 1912.Argentina.
= Phellinus gilvus (Schw.) Pat.
glaucoporus, F. L.M.W. 4:251, 1915.Madagascar.
= Loweporus inflexibilis (Berk.) Ryv.
gossweileri, F. L.M.W. 6:940, 1920. Angola.
= Daedalea sprucei Berk.
graffii, F. L.M.W. 4:272, 1915. Philippine Islands.
= Amauroderma bataanense Murr.
hawaiensis, F. L.M.W. 4:260, 1915. USA.
= Phellinus senex (Nees & Mont) Imaz.
intertextus, F. L.M.W. 7:1111, 1922.Brazil.
= Loweporus roseo-albus (Jungh.) Ryv.
koningsbergii, F. L.M.W. 4:270, 1915. Indonesia.
= Ganoderma australe (Fr.) Pat.
latistipitatus, F. L.M.W. 6:1062, 1921. Japan.
= Coltricia vallata (Berk.) Teng
longinquus, F. L.M.W. 7:1335, 1925.Japan.
= Phellinus sp., sterile and without setae.
longosporus, F. L.M.W. 6:940, 1920.Angola.
= The type is sterile and Lloyd suggested in his description that this is a form of Ganoderma applanatum (Pers.) Pat. and the hyphal system and colour of the type suggest clearly that he was right.
magnosporus, F. L.M.W. 6:1014, 1920. Philippine Islands.
= Phellinus höhnelii (Bres.) Pat.
malvenus, F. L.M.W. 4:282, 1915. Samoa.
= **Perenniporia malvena** (Lloyd) Ryv. comb. nov. Basionym as cited above.
Basidiocarp effused-reflexed, pileus up to 5 cm long and 1 cm wide and distinctly sloping, upper surface black, glabrous and sulcate and with a distinct crust, margin rounded and brown, pore surface pale olivaceous brown, pores round, 6-7 per. mm, partly elongated in the most decurrent parts of the pore surface, tubes pale brown and old pores stuffed with white mycelium, context pale tobacco brown and 1 mm thick.
Hyphal system dimitic, generative hyphae with clamps, hyaline, 3-4 um wide, skeletal hyphae 1,5-4 um wide, thick-walled and strongly dextrinoid, basidia not seen, basidiospores truncate to ellipsoid, thick-walled and dextrinoid,4,5-5 x 3,5-4 um.
The dextrinoid spores and skeletal hyphae clearly put this species in Perenniporia. The black encrusted pileus is similar to that found in P. truncatospora (Lloyd) Ryv. (described from Japan), but this species has larger spores, i.e. 6,5-8 x 5-6 um).
mirabilis, F. L.M.W. 3(33): 3, 1911. Singapore.
= Ganoderma fusco-pallens (Bres.) Humphrey
nontostus, F. L.M.W. 4(48):7, 1913. Madagascar.
= Fomitopsis avellanae (Bres.) Ryv.
olivaceus, F. L.M.W. 5(65):14, 1917. Japan.

= Perenniporia tephropora (Mont.) Ryv.

oroflavus, F. L.M.W. 4:265, 1915. USA.

= Ganoderma annularis (Fr.) Gilbn. USA, Calif. Berkeley, Leg. S.B. Parish, Lloyd no 13958 selected here as lectotype.

oroniger, F. L.M.W. 7:1330, 1924. Malaysia.

= Phellinus pachyphloeus (Pat.) Pat.

ostricoloris, F. L.M.W. 4:257, 1915. Zaire.

= Phellinus linteus (Berk. & Curt.) Teng

perlevis, F. L.M.W. 4:39, 1912.Brazil.

= **Pyrofomes perlevis** (Lloyd.) Ryv. For a description, see Ryvarden and Johansen (1980: 533)

petchii,F. L.M.W. 4:268,1915. Sri Lanka.

= The type is lost, but from the description is is evident that it represents a Ganoderma species in the G. lucidum group. Lloyd interpreted it as a "form of Polyporus lucidus". With the present chaotic state in the laccate Ganoderma species, there is no possibilty to reach any conclusion as to its true identity.

polyzonus, F. L.M.W. 4:269, 1915.Indonesia.

= Ganoderma australe (Fr.) Pat.

pseudoaustralis, F. L.M.W. 4:269, 1915. Philippine Islands.

= Ganoderma australe (Fr.) Pat.

pseudopetchii,F. L.M.W.7:1202, 1923. Indonesia.

= **Fomitopsis pseudopetchii** (Lloyd) Ryv. For a description, see Ryvarden & Johansen 1980:339.

psila, F. L.M.W. 4:233, 1915.Brazil.

= Hexagonia hydnoides (Fr.) Fidalgo, as suggested by Lloyd in the description.

pusillus, F. L.M.W. 4(49):13, 1914.Japan.

= **Phellinus pusillus** (Lloyd) Ryv. comb. nov. Basionym as cited above.

Basidiocarp minute, pendant and conical, 5-8 mm high and wide, dorsally attached with expanding pileus, upper surface glabrous, black and sulcate, pore surface pale brown, pores tiny, 8-9 per mm, tubes stratified, in the type three layers are distinct, context very thin, rusty brown,2-300 um thick. Hyphal system dimitic, generative hyphae 2-3 um wide, hyaline and with simple septa, skeletal hyphae running more or less parallel in the context, and tubes, thick-walled, pale yellowish, 2-4 um wide,setae not seen, basidia not seen, basidiospores globose 5-6 um in diameter, thick-walled and strongly dextrinoid. Collected on Zelkova acuminata (Ulmaceae).

This species belongs to the Phellinus robustus complex because of its globose dextrinoid spores and lack of setae. Its minute dorsally attached basidiocarps are rather unique in the genus and this and possibly the host may be diagnostic.

Japanese mycologist should be aware of the species and see whether it is restricted to Zelkova only.

reviviscens, F. Lloyd in Rick, Broteria ser. Bot. 21:7,1924.Brazil.

= Navisporus sulcatus (Lloyd) Ryv.

rhaponticus, F. L.M.W. 4(44):11, 1913.Japan.

= Phellinus robustus (Karst.) Bourd. & Galz.

rheicolor, F. L.M.W. 4:245, 1915.Argentina.

= Phellinus rhabarbarinus (Berk.) Cunn.
roseotubulus, F. L.M.W. 5(67):14, 1918.Angola.
= Loweporus fusco-purpureus (Pers.) Ryv.
sanfordii, F. L.M.W. 4:258, 1915. Sri Lanka.
= **Phellinus sanfordii** (Loyd.) Ryv. For description, see Ryvarden & Johansen (1980:212).
sanjanii, F. L.M.W. 6:885, 1919.USA.
= Phellinus rimosus (Ber
k.) Pilat
sculpturatus, F. L.M.W. 4:39, 1912.Madagascar.
= **Ganoderma sculpturatum** (Lloyd) Ryv. comb. nov. Basionym as cited above. For a description, see Ryvarden & Johansen (1980:91) as G. neurosporum Furt. The species is common in Central Africa and easy to recognize by the sculptured context which inspired Lloyd to the name.
setulosus, F. L.M.W. 4:243, 1915. Sri Lanka.
= **Phellinus setulosus** (Lloyd) Imaz. For description, see Ryvarden & Johansen (1980:217).
sublamaensis, F. L.M.W. 7:1128, 1922.Philippine Islands.
= **Phellinus sublamaensis** (Lloyd) Ryv. comb. nov. Basionym as cited above. This is a prior name for Phellinus noxius (Corner) Cunn. For a description, see Ryvarden & Johansen (1980:212).
tepperii, F. L.M.W. 4:256, 1915.Australia.
= Phellinus rimosus (Berk.) Pilat
yasudai, F. L.M.W. 4:272, 1915.Japan.
= Phellinus robustus (Karst.) Bourd. & Galz.

HEXAGONIA
angulata, H. L.M.W. 6:1003, 1920.Malaysia.
= Hexagonia tenuis (Hook.) Fr.
atra, H. L.M.W. 7:1156, 1922.Philippine Islands.
= Hexagonia hirta (Fr.) Fr.
burchelli, H. L.M.W. 3:44,1910. Sri Lanka.
= Hexagonia tenuis (Hook.) Fr.
calignosa, H. L.M.W. 7:1156, 1922.Philippine Islands.
= Hexagonia tenuis (Hook.) Fr.
crassispora, H. L.M.W. 5:714, 1917.Ghana.
= Hexagonia speciosa Fr.
dermatiphora, H. L.M.W. 3:501, 1911.Zaire.
= Accepted in the genus. For a description, see Ryvarden & Johansen (1980:212).
ferruginosa, H. L.M.W. 6:1016, 1920. Philippine Islands.
= Gloeophyllum imponens (Ces.) Imaz.
flavofusca, H. L.M.W. 7:1156, 1922. Philippine Islands.
= Lenzites acuta Berk.
lignosa, H. L.M.W. 6:884, 1919. Mauritius.
= Coriolopsis asper (Jungh.) Teng
lineata, H. L.M.W. 7:1194, 1923. Zaire.
= Hexagonia dermatiphora Lloyd
mirabilis, H. L.M.W. 3:37, 1910. Samoa.
= Pseudofavolus cucullatus (Mont.) Pat.
murina, H. L.M.W. 7:1242, 1924. Indonesia.
= Lenzites acuta Berk.
olivacea, H. L.M.W. 4:53, 1914. Australia.
= Lenzites vespacea (Pers.) Ryv.

= Hexagonia hirta (Fr.) Fr.
scruposa, H. L.M.W. 7:1155, 1922. Philippine Islands.
= Daedalea sulcata (Berk.) Ryv.
smallii, H. L.M.W. 5:748, 1917. Uganda.
= Hexagonia dermatiphora (Lloyd) Ryv.
umbrosa, H. L.M.W. 6:957, 1920. Singapore.
= Hexagonia tenuis (Hook.) Fr.
velutino-glabra, H. L.M.W. 7:1193, 1923. Angola.
= Coriolopsis floccosa (Jungh.) Ryv.

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Page 238 line 5 for *Microlynchus* read *Microlychnus*

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ECHINOPLACA FURCATA, A NEW SPECIES OF FOLIICOLOUS LICHEN (GOMPHILLACEAE) FROM RWANDA

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Summary. - *Echinoplaca furcata* Sérusiaux is described as new from Rwanda (Central-East Africa) where it is epiphyllous in montane rain forest. It is easily distinguished by its repeatedly and irregularly branched cilia growing on the prothallus and by the presence of needle-shaped crystals on the surface, emanating from the disintegrating excipulum.

Generic concepts in the lichen family Gomphillaceae W. Watson ex Hafellner have been recently revised by Vězda & Poelt (1987) who recognize ten genera : *Gomphillus* Nyl., *Actinoplaca* Müll. Arg., *Aulaxina* Fée, *Bullatina* Vězda & Poelt, *Calenia* Müll. Arg., *Caleniopsis* Vězda & Poelt, *Echinoplaca* Fée, *Gyalectidium* Müll. Arg., *Gyalideopsis* Vězda and *Tricharia* Fée. Since their survey of accepted taxa in these genera, thirty-one additional species have already been described (Kalb & Vězda 1988, Sérusiaux & De Sloover 1986, Vězda & Hafellner 1988); this clearly demonstrates how widespread, diverse and poorly known the family is, especially in tropical areas.

Much work remains to be carried out in this family, even at the generic level. Indeed there is little doubt that the following genera belong to it : *Epilithia* Nyl., *Microlynchus* Funk, *Microspatha* P. Karsten and *Szczawinskia* Funk (Funk 1973 and 1983; Seifert 1985).

The aim of this paper is thus rather modest as it deals with just a single new foliicolous species of *Echinoplaca* found in Rwanda (Central-East Africa).

Echinoplaca furcata **Sérusiaux sp. nov.** Fig. 1.

Thallus epiphyllus, dispersus, viridulus vel cinereo-viridis, cum albis verrucis e crystallis compositis, hyphophoris instructus; hyphophori 0.4(-0.5) mm longi, albidi vel pallido brunnei, setiformes, arcuati, cum conidica massa. Prothallus pilis instructus; pili 0.6-0.8 mm longi, albidi vel pallide brunnei, simplices vel irregulariter ramosissimi.

Apothecia orbicularia, 0.3-0.5(-0.7) mm lata, aurantiaco-brunnea; excipulum crystallis albis acicularibus mox obtectum, demum fatiscens et crystallinescens.

Hymenium 45-55 μm altum cum luteo-brunneo epihymenio; paraphyses ramosae anastomosantesque; asci 1-spori, saccati; sporae ellipsoideae usque fere sphaericae, murales, (26-)28-42 x (38-)40-52 μm.

Alga cellulis globosis viridibus, 10-12 μm diam., ad familiam Chlorococcacearum verosimiliter pertinens.

Thallus epiphyllous, up to 1.2 cm large, made up of orbicular to irregular patches not exceeding 0.4 mm in diam., greenish to grey-green, or almost pure white when covered with crystals, rather shiny, covering irregular clusters of angular crystals which give it a verrucose appearance (verrucae paler than the thallus, 0.2-0.5 mm in diam.), with a large (up to 0.6 cm wide) translucid prothallus between and around the patches. Corticiform layer of hyaline interwoven hyphae.

Cilia numerous over the prothallus, 0.6-0.8 mm long, simple and tapered towards their tip or repeatedly and irregularly branched, sometimes forming a mat of entangled threads around the thallus patches, whitish to pale brown, usually dirty because of accumulations of various fragments (incl. plants diaspores, and pollen grains).

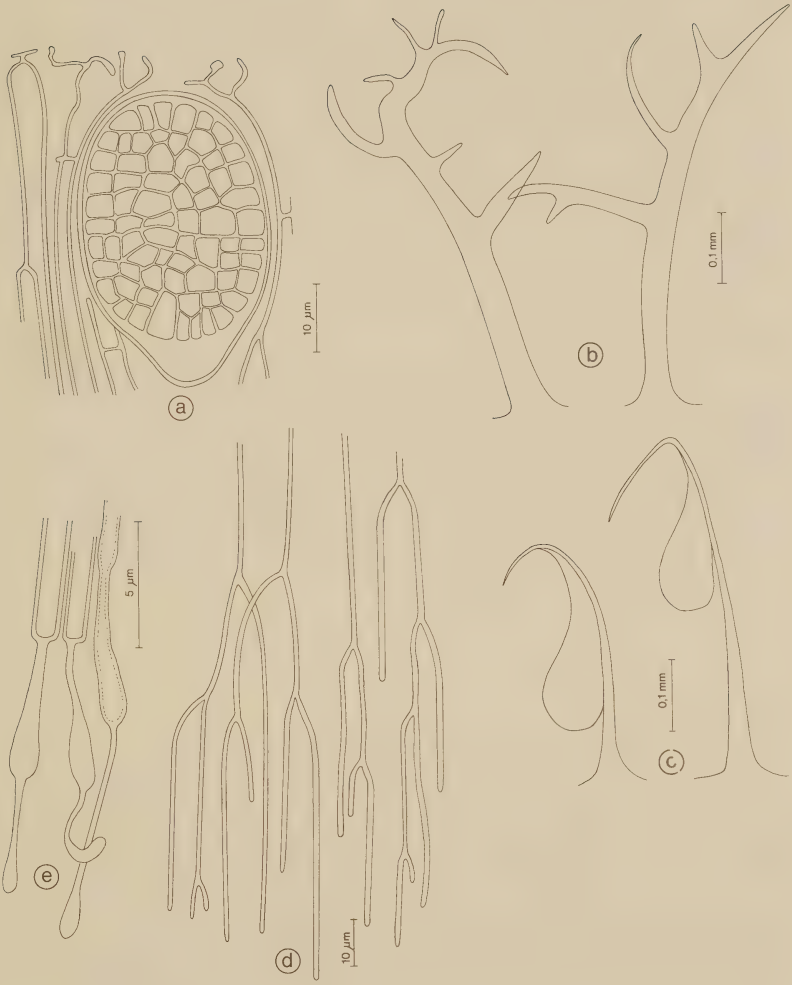
a
10 µm
b
0,1 mm
c
0,1 mm
d
10 µm
e
5 µm

Fig. 1. *Echinoplaca furcata* Sérusiaux, holotype.
a - Hymenium, including an ascus with immature spore. b - Cilia. c - Hyphophores. d - Detail of the conidial mass (squash in water). e - Detail of the racket-like cells at the ends of hyphae present in the conidial mass.

Hyphophores absent on most specimens examined but numerous when present, growing only on thallus patches, 0.4(-0.5) mm long, whitish to pale brown, looking like long cilia, curved downwards near their tip, carrying a single conidial mass which is tear-shaped and stuck to the axis. Conidial mass hanging on the hyphophore tip by a few thick hyphae, made of long-branched thick hyphae (wall up to 1.5 μm when mounted in a KOH solution, cells reaching 15-20 μm long) carrying racket-like cells assumed to be the conidiophores, conidiogenous cells and conidia.

Apothecia numerous, orbicular, 0.3-0.5(-0.7) mm in diam., sometimes confluent, adnate on the thallus surface and expanding laterally over it (algal cells can thus be seen under most of the apothecium), sometimes developing over crystals clusters of 0.1-0.3 mm in diam.; disc orange brown. Margin soon covered by large amounts of white needle-shaped crystals (needles up to 150-200 μm long, easily seen under the dissecting microscope), coming out of the disintegrating excipulum, eventually invading the thallus and apothecia surface, breaking up into pieces and aggregating into angular clusters.

Excipulum formed by branched hyphae embedded in a pale brown gelatinous mass, easily observed in young apothecia but eventually disrupted by the formation of crystals; hypothecium hyaline, less than 10 μm high; hymenium 45-55 μm high with a distinct epihymenium mainly composed of crystals and a yellowish-brown gelatinous mass; paraphyses 1 μm thick, branched and anastomosed; asci 1-spored, saccate; spores ellipsoid to almost spherical, muriform, (26-)28-42 x (38-)40-52 μm.

Photobiont most probably belonging to the Chlorococcaceae, with green, globose cells (10-12 μm in diam.).

Material examined :

Rwanda, afromontane district, Nyungwe forest, near Kamiranzovu, 1950 m elev., dense rain forest on hydromorphic soil, on living leaves of *Beilschmiedia* (Lauraceae), Sept. 1971, coll. G. Bouxin 1119 (LG-holotypus). Ibid., Nyungwe forest, at Ruwankuba, 2000 m elev., dense rain forest on hydromorphic soil, on living leaves of *Ocotea* (Lauraceae), Feb. 1971, coll. G. Bouxin 1314 (LG). Ibid., Rugege Forest, Ruwankuba, 1950 m elev., riverine forest with *Sysygium guineense*, on living leaves of *Marattia fraxinea* (Marattiaceae), Dec. 1971, coll. J. Lambinon 71/1062 (LG). Ibid., Rugege Forest, hill between Muzimu Mt and Bigugu, ahead of river Kalundra, 2350 m elev., dense rain forest, on living leaves of *Schefflera myriantha* (Araliaceae), March 1972, coll. J. Lambinon 72/958 (LG).

Echinoplaca furcata is easily distinguished from all other representatives of the Gomphillaceae by its repeatedly and irregularly branched cilia growing only on the prothallus. To my knowledge, no other species presents these criteria. Cilia growing on the prothallus are rare in the genus *Echinoplaca* : only *E. atrofusca* R. Sant. has pale brown simple hairs on its prothallus.

E. furcata has an apothecium anatomy and hyphophores typical of the genus and there is thus no doubt about its generic position.

Echinoplaca furcata is also easily separated from other *Echinoplaca* species with 1-spored asci (*E. epiphylla* Fée and *E. similis* Kalb & Vězda) by the presence of long needle-shaped white crystals, at least on the excipulum outer surface. These crystals are not an artefact as in the four above cited collections, they are restricted to *E. furcata*, and are not present on associated species, including other representatives of the Gomphillaceae.

Acknowledgements

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PHYTOPHTHORA NICOTIANAE (P. PARASITICA)

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ABSTRACT

A comparative study of 35 isolates of *Phytophthora nicotianae* (*P. parasitica*) from different plant hosts was conducted under uniform conditions and the results failed to distinguish them into two morphological varieties as established by Waterhouse (1963). *Phytophthora nicotianae* and *P. parasitica* are conspecific but based on the International Botanical Nomenclature, the epithet *nicotianae* must be retained over *parasitica* which it antedates, despite the ambiguity and incompleteness of the original description of *P. nicotianae*.

INTRODUCTION

Phytophthora nicotianae Breda de Haan was first described by Breda de Haan (1896) causing seed-bed diseases of tobacco in Java. He did not provide a formal diagnosis and his description was incomplete. His failure to isolate the fungus on pure culture and his description and drawing of paragynous antheridia have been confusing and misleading to many researchers. Thus Lodewijks (1909) did not identify the tobacco *Phytophthora* as *P. nicotianae* partly because it could be grown readily in culture. Dastur (1913) distinguished *P. parasitica* Dastur on castor oil plant as a new species different from all other species of *Phytophthora* (including *P. nicotianae*) except *P. colocasiae* in the development of amphigynous antheridia. Similarly, Rosenbaum (1917) placed *P. nicotianae* in *Cactorum* Group characterized by predominantly paragynous antheridia to distinguish it from *P. parasitica* in *Phaseoli* Group with amphigynous antheridia while Lafferty & Pethybridge (1922) considered *P. nicotianae* a unique species within the genus in having exclusively paragynous antheridia. The erection of *P. parasitica* var. *rhei* Godf. on rhubarb (Godfrey, 1923) and *P. tabacci* Saw. on tobacco (Sawada, 1927) to distinguish from *P. nicotianae* was also partly due to their amphigynous antheridia, in contrast to the paragynous antheridia in the original description of *P. nicotianae*.

Leonian (1925) first questioned the taxonomic status of *P. nicotianae*. The isolate of *P. nicotianae* he received initially from Holland resembled two of Dastur's authentic isolates of *P. parasitica*, morphologically and physiologically. Tisdale & Kelly (1926) compared the black shank *Phytophthora* from tobacco in Florida with isolates of *P. nicotianae* and *P. parasitica* and found them very similar in morphology, but chose to treat it as a biological strain of *P. nicotianae* on account of their common pathogenicity towards tobacco. Ashby (1928) pointed out that Breda de Haan probably was not dealing with the same fungus all the time and the oospores he described for *P. nicotianae* actually belonged to a *Pythium* species. Consequently, he eliminated *P. nicotianae* as an independent species and included it in *P. parasitica* and the species description of the latter was amended. In his monograph on *Phytophthora*, Tucker (1931) accepted Ashby's species concept of *P. parasitica* and considered it synonymous with *P. melongenae* Saw., *P. allii* Saw. (Sawada, 1915), *P. terrestris* Sherb. (Sherbakoff, 1917), and *P. parasitica* var. *rhei*, but he rejected the intraspecific subdivision based on oospore size as proposed by Ashby (1928). Instead, he treated *P. nicotianae* as a variety of *P. parasitica*: *P. parasitica* var. *nicotianae*, synonymous with *P. tabacci* based on their specific pathogenicity to tobacco. Tucker's taxonomic treatment of *P. parasitica* was promptly and widely accepted by other workers until Waterhouse (1963) proposed that whereas *P. parasitica* was not specifically different from *P. nicotianae*, the latter antedated the former and should have priority. She further distinguished *P. nicotianae* into two morphological varieties: (1) *P. nicotianae* var. *parasitica*, synonymous with *P. formosana* Saw., *P. lycopersici* Saw, (Sawada, 1943), *P. ricini* Saw. (Sawada, 1942), *P. parasitica*, *P. parasitica* var. *piperina* Dast. (Dastur, 1935) and *P. tabacci*, (2) *P. nicotianae* var. *nicotianae*, synonymous with *P. allii*, *P. melongenae*, *P. parasitica* var. *rhei* and *P. terrestris*. However, researchers experienced great difficulty in differentiating these two varieties because many isolates had overlapping characteristics (Shepherd, 1976; Tsao & Sisemore, 1978; Caccilo & de San Lio, 1988). While authors began to adopt Waterhouse's species concept of *P. nicotianae*, many still preferred Tucker's treatment of *P. parasitica*. Consequently, there was considerable confusion in the literature. Erwin (1983) rightly pointed out that all tobacco isolates identified as *P. parasitica* var. *nicotianae* might not be synonymous with *P. nicotianae* var. *nicotianae* whereas all non-tobacco isolates, referred to as *P. parasitica* might not be synonymous with *P. nicotianae* var. *parasitica*, and he urged that the nomenclature of this group be re-redefined. The purpose of this study was to compare a wide variety of isolates of *P. nicotianae* (*P. parasitica*) from different hosts to determine if they can be distinguished into two morphological varieties and which epithet should be used for the species.

MATERIALS AND METHODS

Isolates and media: Specific information on the isolate of *P. nicotianae* (*P. parasitica*) used is given in Table 1. All isolates were obtained from the American Type Culture Collection (ATCC), Rockville, Maryland. Unfortunately, *P. nicotianae* never had a type culture and apparently, the type culture of *P. parasitica* is no longer in existence. Unless otherwise stated, clarified V-8 juice agar medium (Ribeiro, 1978) supplemented with sitosterol (30 mg/l) was used for culture.

Morphology: Colony characteristics on CV8, and Difco cornmeal agar (CMA) were compared after incubating in darkness at 20 C for 7 days. The colony diameters on CV8 were measured at right angle through the inoculum and the width of primary hyphae measured under light microscope. The minimal and maximal temperatures for growth were tested by growing them on CV8 and CMA at 10 C and 35 C. Sporangia were produced by incubating small mycelial agar discs of CV8 in freshly collected stream water sterilized by filtration through 0.45 μm pore size millipore membrane discs and incubating under light at 20 C. Production of sex organs in single cultures was followed by examining them periodically under microscope through the bottom of the petri dish. If the isolate failed to produce sex organs readily in single culture, it was paired with the appropriate mating types of P. nicotianae (ATCC 38606, A_2 and ATCC 38607, A_1). In case of a successful mating, the ability of the isolate to produce sex organs by selfing was confirmed by pairing it with the compatible strain across a polycarbonate membrane to prevent physical contact between the cultures (Ko, 1978). They were examined for sex organs after 2-3 wk incubation in dark at 20 C.

RESULTS

Colony morphology: On CV8, isolates of *P. nicotianae* (*P. parasitica*) ranged from uniform, diaphanously fluffy to irregularly rosette, tufted and submerged. With age, the plates turned brownish. The hyphae ranged from uniformly wide (approximately 5 µm) to very uneven (2-18 µm). In old agar plates and water cultures, spherical to irregular hyphal swellings up to 20 µm diameter were commonly produced, singly, in chains or clusters. Often the swellings looked "spiked" in possessing several radiating hyphae growing from them. On Difco CM, the colonies were primarily submerged with more conspicuously irregular and tufted mycelial growths.

The average daily growth rate of the isolates on V8C was 2-8 mm per day at 20 C and they all grew at 35 C. The ability to grow at 10 C varied with the isolates (Table 2).

Sporangium: Sporangia were produced on CV8 agar plates by all isolates, but more abundantly and more promptly in water, usually within 24-48 hr. They were distinctly papillate with hemispherical apical thickenings, spherical to broadly ovoid or obpyriform with round bases. The overall mean dimensions of sporangia (Table 2) for all isolates were 47±5 µm long and 35±4 wide, with an overall mean L/B ratio of 1.4±0.1. Occasionally, the sporangial apex prolonged into a beak or the sporangium had two apices. Beaked sporangia were especially common for isolates ATCC 13612, 22598, 38606, and 38607 when they were paired with the appropriate mating types, separated by a polycarbonate membrane. Under these conditions, elongated sporangia resembling the "abnormal sporangium-like structures" reported by Thompson & Hine (1972) and the vesicular sporangia (Dastur, 1913; Sawada 1927; Richardson, 1941; Vanderweyen 1983) were also formed although they could sometimes be found in water as well. They were tubular or lobulate, septate or non-septate with the terminal segment filled with cytoplasm and often capped with apical papilla. These were interpreted as externally proliferating sporangia under unfavorable conditions when the sporangium failed to mature normally but continued to grow and develop, resulting in an elongated or multiple-sporangium like structure. Sometimes, the sporangium could germinate directly to give rise to another sporangium or a chain of several sporangia.

The sporangia were borne terminally, singly or sympodially on slender sporangiophores (2-3 µm) or produced intercalarily by undifferentiated hyphae. In some cases, the sporangia either possessed short hyphal appendages in the basal portion or they were subtended by several hyphae. Sporangia were primarily non-deciduous although a low percentage of detached sporangia either with short occluded pedicels (<5 µm) or of uneven length could be found in some isolates, e.g. ATCC 26009, 36997, 46293, 46294, 56602, and 64535.

Encysted zoospores germinated by one or more germ tubes. Occasionally, instead of subsequently developing into a branching hypha, the germ tube was terminated by a microsporangium (Thompson & Allen, 1976). The production of microsporangia by germinating cysts was especially common for zoospores which were trapped and encysted within the sporangia as described by Drechsler (1930). However, repeated emergence of zoospores directly from cysts were seen only rarely in isolate ATCC 46293.

Chlamydospores: All isolates with the exception of ATCC 15409 and 46063 produced chlamydospores in varying amounts in 2-week old agar plates. Some isolates like ATCC 22597, 38607, 36997, 60439 and 64534 produced chlamydospores promptly and abundantly in water within 48 hr. The size of chlamydospores varied considerably with the overall mean diameter for all the isolates (Table 3) measuring 33±4 µm and the maximum about 60-70 µm. They were oval to spherical, terminal or intercalary with the chlamydospore wall 1-2 (-3) µm thick. Except for isolate ATCC 46063, they all eventually developed straw-colored to brown pigmentation with time on V8C. Isolate ATCC 64536 probably had degenerated because it produced sparsely, small poorly developed "chlamydospores" on agar plates and abnormal, elongated sporangia in water.

Sex organs: All isolates behaved heterothallically (Savage *et al*., 1968) producing sex organs abundantly by mating with the appropriate partners. Whereas sex organs were not produced in single cultures except occasionally upon aging (Tsao *et al*., 1980) isolate ATCC 15407 was unique in forming sex organs readily by itself. Self-fertile isolates of *P*. *parasitica* (*P*. *nicotianae*) have been reported previously (Apple, 1959; Haasis & Nelson, 1963; Suzui *et al*., 1978). Changes in mating type (Ko, 1981; Arentz, 1986) were not observed except in ATCC 60439 which proved to belong to A_1 mating type instead of being homothallic as determined initially (Sansome, 1980). Since it was impossible to determine exactly which partner(s) actually produced the sex organs in paired cultures on agar plates, measurements were taken from selfed sex organs produced by each partner when paired across a membrane (Table 3). Unfortunately, some isolates though mated readily in paired cultures on agar plates, never selfed on membrane or in old plates, suggesting the existence of hybridization in these crosses as demonstrated convincingly in *P*. *infestans* (Shattock *et al*., 1986). As observed previously in *P*. *cinnamomi* (Ho & Zentmyer 1977) and *P*. *cryptogea* (Ho & Jong, 1986), the oogonia formed as a result of crossing in dual cultures were slightly smaller than those formed by selfing. For instance, the oogonia formed in the cross between ATCC 38606 (A2) and ATCC 38607 (A1) averaged 24±2 μm in contrast to those formed by selfing (28±2) when the mating strains were physically separated by a membrane.

When mature, the oogonia turned brown, often with a conspicuous layer of amorphous deposits on the surface (Ho, 1979). The overall mean diameter of the oogonia and oospores for all isolates (Table 3) were 29±2 μm and 23±2 μm, respectively. Oogonia were invariably spherical although distorted oogonia as observed by Sansome (1985) were found in ATCC 15408. In certain isolates, e.g., ATCC 38606, 46732 and 64535, pigmented oogonium-like structures similar to those described by Bell & Haasis (1967) were found, devoid of contents and antheridia. They were especially common when paired on membrane and were considered as aborted oogonia which were prevented from fertilization by the membrane. Antheridia were short, non-pigmented and unicellular, measuring 10±1 μm long and 12±1 μm wide for all isolates. Eccentric oogonial stalk within the antheridium as described by Waterhouse (1963, 1974) was found rarely and randomly.

DISCUSSION

Ever since Breda de Haan (1896) erected P. nicotianae for the fungus on tobacco seedlings in Java, the species has been questioned by many workers. Firstly, he never isolated and described the fungus in pure culture and secondly, his description and figuring of paragynous antheridia confused and misled later researchers. Often, workers referred their Phytophthora isolates from tobacco as P. nicotianae without being certain that their isolates were the same as the one seen by Breda de Haan because all of them could be easily cultured and produced only amphigynous antheridia.

Breda de Haan's description of the sexual organs in P. nicotianae can be interpreted in two ways. The paragynous antheridia as described and figured by him indeed pertained to P. nicotianae. At least, Nolla (1928) included paragynous-like antheridia in his drawing of black shank Phytophthora of tobacco from Puerto Rico. On the other hand, Ashby (1928) pointed out that the oospores in Breda de Haan's specimen probably belonged to Pythium which attacked tobacco seedlings causing indistinguishable symptoms in Java at the same time. Meurs (1934) further suggested that the contaminant could be Pythium deliense Meurs based on the similarity in the fertilization process. No oogonial measurement was provided by Breda de Haan but Waterhouse (1970) stated that "from the magnifications given with the figures the measurements of the oogonia can be calculated as 28x25 μm, 20x16.6 μm, and 23.3x21.6 μm, and the oospore 16.6 μm diam." However, our measurements showed that the oogonia were approximately 23x20, 17x15 and 19x15 μm and the oospore 15 μm diam, agreeing more with Tucker's mentioning of "oogonia 19 μm in diameter" for P. nicotianae (Tucker, 1931). Oogonia of that small size are unknown in literature for isolates from tobacco. On the other hand, Meurs (1934) described the oogonia of Pythium deliense as "varying from 15-23.1 μm in diameter, mostly 16.1-20.0 μm, average 18.2 .... oospores average 14.8 μm". Thus, it seems highly probable that Breda de Haan's description of P. nicotianae was based on two fungi belonging to different genera. If so, the epithet probably could have been rejected in accordance with Article 70 of the International Code of Botanical Nomenclature (Stafleau, et al., 1972). However, this article has been deleted from the most recent Code (Voss et al., 1983).

With the notable exception of Rosenbaum (1917) who was probably working on an isolate wrongly identified as *P. parasitica* (Godfrey, 1923; Ashby, 1928) the great majority of researchers agreed that the isolates from tobacco known as *P. nicotianae* could not be specifically distinguished from isolates of *P. parasitica* from other hosts, but they were sharply divided in the use of the epithets. Dastur's detailed original and Ashby's succinct amended account of *P. parasitica* allowed the researchers to identify their isolates readily as belonging to this species without any lingering doubts. On the other hand, unless and until separate rules are adopted for fungi as suggested by Brasier (1983), the International code of Botanical Nomenclature must be observed to ensure uniformity in fungal nomenclature. Based on the principle of priority as contained in Article 11, it is mandatory to retain the epithet *nicotianae* over *parasitica* which it antedates. Article 51 further stipulates that "an alteration of the diagnostic characters or of the circumscription of a taxon does not warrant a change in its name". Thus, in spite of the ambiguity of the antheridial configuration of *P. nicotianae*, the epithet cannot be rejected. Although Gallegly (1983) pointed out the anamoly that "*nicotianae* implies host specificity and *parasitica* implies a braod host range", Article 62 prohibits the rejection of a legitimate epithet merely because it is "inappropriate or disagreeable, or because another is preferable, or better known, or because it has lost its original meaning". The lack of formal description does not invalidate the name *nicotianae* which was published before Jan 1, 1908 and thus accepted as valid in accordance with Article 44. However, in view of the long established usage of the name *P. parasitica* and the fact that it is a species of major economic importance attacking a wide variety of plants world-wide, plant pathologists can conceivably conserve the epithet *parasitica* under Article 14, but a formal proposal has to be submitted and approved by the International Botanical Congress.

Waterhouse's creation of two morphological varieties within the species *P. nicotianae* further compounded the nomenclatural problem of this group, because many workers found it very difficult, if impossible, to differentiate these two varieties. According to Waterhouse (1963), *P. nicotianae* var. *nicotianae* is characterized by uniformly fluffy colony with minimal growth temperature above 10 C, uniform hyphae, spiked hyphal swellings, abundant chlamydospores not turning brown, non-deciduous, beaked sporangia and eccentric oogonial stalk whereas P. nicotianae var. parasitica produces irregular rosette colonies with minimal growth temperature at or below 10 C, irregular hyphae, pigmented chlamydospores forming tardily with thicker wall, deciduous, smaller, non-beaked sporangia and smaller oogonia. Our findings based on the comparative morphological study of 35 isolates of P. nicotinae (P. parasitica) failed to separate them into two distinct varieties. In our study, the cultural appearance varied from appressed, distinctly tufted and irregular to uniformly fluffy and the hyphae also ranged from uniform to highly uneven. There was no correlation between growth pattern and the mating type or the host from which the isolate originated. Apple (1957) and Shepherd (1976) noted that even among isolates from tobacco, both smooth, fast growing colonies (mating type A1) and irregular, slow growing colonies of submerged arbuscular mycelium (mating type A2) could be found. Variabilities in colony morphology and hyphal characteristics were also found among the dissociants from rhubarb isolate (Leonian 1926, 1934). The production of spiked hyphal swellings and the ability to grow at 10 C were too variable to be of much significance in intraspecific classification. Spiked swellings occurred occasionally in some isolates in our study and in literature. The minimal temperatures for growth for isolates referrable as P. nicotianae var. nicotianae and P. nicotianae var. parasitica were 5-15 and 5-13 C respectively in literature. Even Waterhouse later accepted 5-12 C as the minimal growth temperature for both varieties (Waterhouse, 1974).

The ability to produce chlamydospores seemed to vary with the isolate rather than a stable diagnostic character of the taxon. There was no significant differences in the chlamydospore diameter or wall thickness. The overall means of chlamydospore diameters for isolates referrable as P. nicotianae var. nicotianae and P. nicotianae var. parasitica were 31±5 μm and 32±4 μm respectively based on literature and 33±4 μm and 34±8 μm respectively based on our measurements. Although Waterhouse (1963) distinguished the chlamydospores of P. nicotianae var. nicotianae measuring 20-40 μm from P. nicotianae var. parasitica" up to 60 μm, she later cited 22-30 μm for the chlamydospore diameter of the latter (1974) implying little or no difference in chlamydospore size between these two varieties. She also separated the two varieties based on the timing of chlamydospore formation and the pigmentation as well as the thickness of chlamydospore wall. We found that the timing was a variable character and in nearly all isolates, the chlamydospores wall measured 1-2 μm thick, eventually turning yellowish brown. This observation was also commonly made by authors working on isolates of P. nicotianae (P. parasitica) in the past. Waterhouse considered the sporangia of P. nicotianae var. nicotianae distinct in having the basal part nearly spherical with the apical third or quarter narrowed and prolonged into a 'beak'. Beaked sporangia were found in some isolates identified as "P. nicotianae var. nicotianae" or "P. nicotianae var. parasitica" and they were more commonly produced under less than favorable conditions, for example, on membranes in pairing experiments. The hyphal appendages of sporangia proved to be a poor diagnostic character. We also failed to confirm Waterhouse's distinction between the two varieties based on the caducity of sporangia. In present study, the sporangia in all isolates were primarily non-deciduous although in some isolates, a low percentage of sporangia were found dropping off in water with a short occuled pedicel (<5 μm long). Thus, our observations agreed with those reported earlier by Al-Hedarthy & Tsao (1979) and Trichelo & Aragaki (1982) regarding the noncaducity of the sporangia of P. parasitica. Whereas most authors did not comment on the caducity of sporangia Tucker (1931) concluded that although in most isolates of P. parasitica the sporangia fell away without a persistent pedicel, this was a variable character.

In Waterhouse's key of 1963, P. nicotianae var. nicotianae was distinguished from P. nicotianae var. parasitica in producing larger sporangia with mean length over 40 μm. However, in our study, many isolates produced sporangia over 40 μm (Table 2). When the frequency distribution of mean sporangial lengths of all isolates studied here were plotted, the graph clearly showed continuous variation with no gap to suggest possible intraspecific differentiation (Fig. 1). Similar result was obtained using published data in literature, with the median length of sporangia 40-42 μm instead of 43-45 μm in our study. The slight discrepancy could be attributable to the different methods of sporangial production and measurement. In any case, it is simply impossible to distinguish the two varities based on the sporangial length being over or under 40 μm.

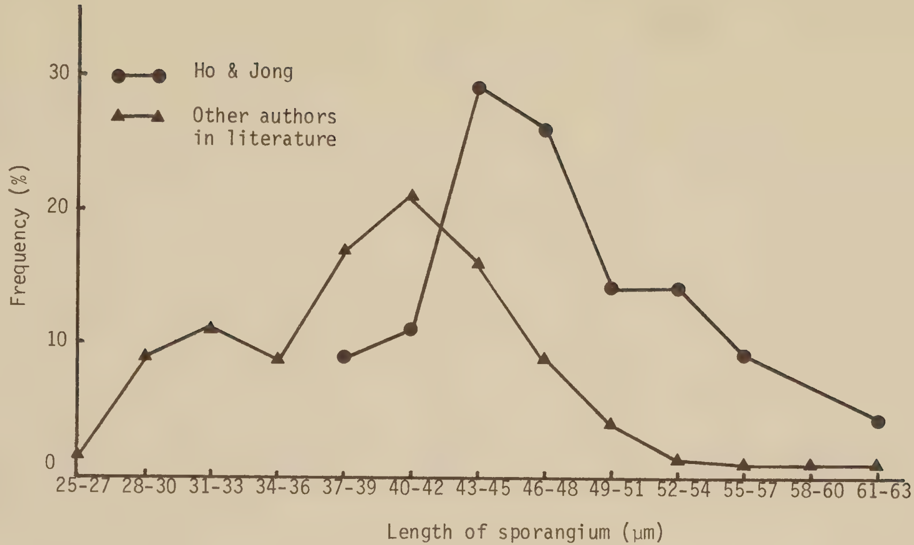

Fig. 1. Mean sporangial lengths of Phytophthora nicotianae

Waterhouse (1963) considered the oogonia of _P_. _nicotianae_ var. _nicotianae_ larger than those of _P_. _nicotianae_ var. _parasitica_ (28-30 vs 24-26 μm). The frequency distributions of oogonial diameters of isolates of _P_. _nicotianae_ (_P_. _parasitica_) studied here and by previous workers (Fig. 2) again show continuous variations without any conspicuous break in the curves to justify the separation of two varieties.

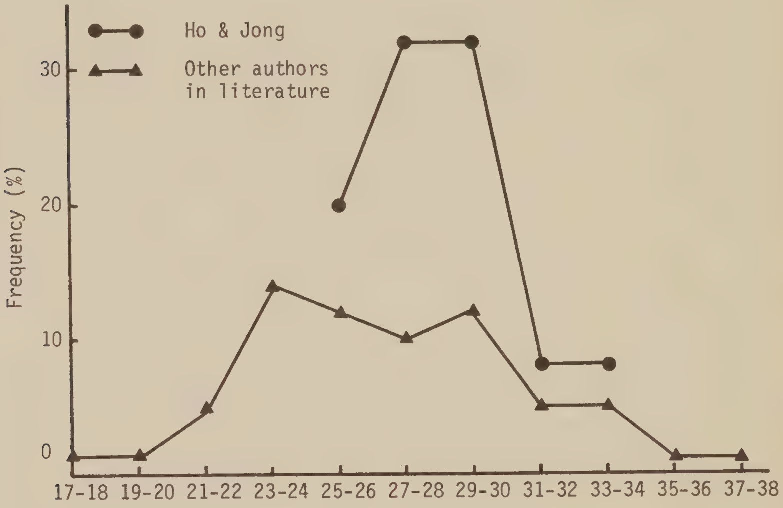

Fig. 2. Mean oogonium diameters of _Phytophthora_ _nicotianae_

According to Waterhouse (1974), the oospores of _P_. _nicotianae_ var. _nicotianae_ measured over 20 μm whereas _P_. _nicotianae_ var. _parasitica_ produced oospores under 20 μm. The median diameters of oospores for all isolates of _P_. _nicotianae_ (_P_. _parasitica_) studied by us was 21-22 μm and 19-20 μm based on published data and the frequency distributions showed continuous variations (Fig. 3). Thus the oospore diameter being greater or smaller than 20 μm is clearly of little diagnostic value. Furthermore, the overall mean values for the oogonial and oospore diameters for isolates referrable as _P_. _nicotianae_ var. _nicotianae_ were 29±3 and 23±3 μm respectively in our study; 27±4 and 21±4 μm based on literature, while isolates referrable as _P_. _nicotianae_ var. _parasitica_

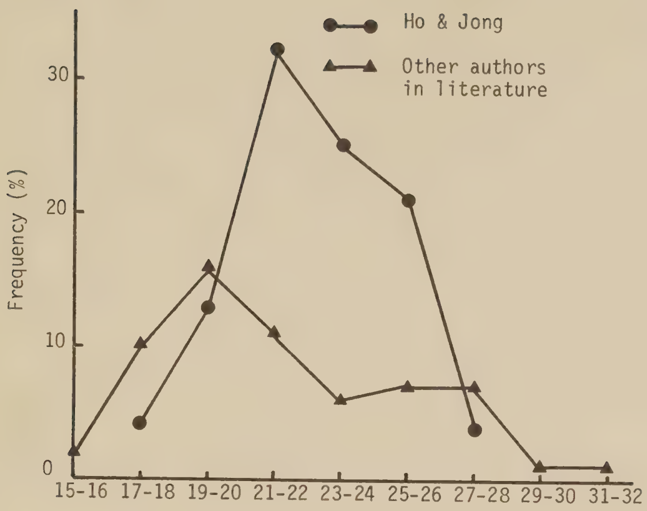

Fig. 3. Mean oospore diameters of Phytophthora nicotianae

produced oogonia and oospores averaging 29±2 and 23±2 μm diam in our study and 27±4 μm and 22±4 μm diam based on published data. These measurements strongly suggest that they should belong to the same taxon.

Waterhouse (1963, 1974) claimed that the oogonial stalk of P. nicotianae var. nicotianae was very eccentric, appearing to be not amphigynous at first sight. In all our isolates studied, we never had any difficulty in determining the antheridial type to be amphigynous because the oogonial stalks were predominantly central in position. Eccentric oogonial stalks were seldom observed and was not mentioned in literature.

In summary, our findings were in agreement with those of Tsao & Sisemore (1978) who reported a high degree of variability among the isolates from citrus, tomato and tobacco and questioned the separation of the species into two varieties. In fact, the difficulty or impossibility to differentiate these two varieties is apparent from the considerable overlapping in diagnostic characters as recorded in literature (Tables 4 & 5).

Waterhouse's disposition of similar taxa described earlier was also confusing. She (1974) stated that *P. nicotianae* var. *nicotianae* included Ashby's "*macrospora*" group with larger oospores and *P. nicotianae* var. *parasitica* corresponded to "*microspora*" group with smaller oospores. However, Waterhouse (1963) considered *P. formosana*, *P. lycopersici* and *P. ricini* synonymous with *P. nicotianae* var. *parasitica*, even though they all possessed larger oospores (19-25, 22-27 and 24-26 μm, respectively in original descriptions). On the other hand, *P. melongenae*, *P. allii* and *P. terrestris* were treated as synonymous with *P. nicotinae* var. *nicotianae* despite their smaller oospores (17-21, 17 and 18-21 μm, respectively in original descriptions). Her treatment of *P. parasitica* var. *piperina* was puzzling. It was listed as synonymous with *P. nicotianae* var. *parasitica* in the key but considered the same as *P. nicotianae* var. *nicotianae* in the text (Waterhouse, 1963).

The differentiation of the species into two less than distinct morphological varieties often cast doubt on the true identity of the pathogen. Thus, *Phytophthora* species on tobacco, tomato, eggplant, peperomia and agave were identified by different workers in different parts of the world as *P. nicotianae* var. *nicotianae*, *P. nicotianae* var. *parasitica* or both (Waterhouse & Waterston, 1964 a,b; Tamori, 1974; Holliday, 1980; Humphrey Jones, 1980; Shenoi *et al*., 1985; Flett, 1986). Liu (1977) reported both varieties on citrus, papaya, tomato, peppers and orchids in Malaysia. Although Weststeijn (1973) named the tomato *Phytophthora* in Holland as *P. nicotianae* var. *nicotianae* he admitted that it was probably the same as *P. parasitica* reported on tomato by workers in other countries. The confusion over these two varieties of *P. nicotianae* led some authors to disregard them completely (Zhuang, 1981; Krober, 1985; Gerrettson-Cornell, 1985; Cacciola & di San Lio, 1988). It is also our opinion that the separation of the species into two morphological varieties is not warranted. Furthermore, the serological study of Morton & Dukes (1967), the nutritional studies of Mehrotra (1951) and Roncadori (1965), the enzyme study of McIntyre & Hanlin (1978), the protein pattern analysis of Erselius & de Vallavieille (1984) and the immunoelectrophoresis work of Cristinzio *et al*. (1983) have all failed to support the separation of two varieties of *P. nicotianae* (*P. parasitica*). It is difficult to understand why Waterhouse (Gallegly, 1983) stated that *P. nicotianae* var. *nicotianae* and *P*. *nicotianae* var. *parasitica* could be treated even as two separate species if she (1963) considered *P*. *parasitica* specifically not different from *P*. *nicotianae* in the first place. Gallegly's suggestion (1983) of naming two different species based on host specificity is not acceptable according to the Code.

Isolates of *P*. *nicotianae* (*P*. *parasitica*) supposedly specific to certain plant hosts were sometimes further assigned subspecific epithets. Thus Kale & Prasad (1957) reported that *P*. *parasitica* var. *sesami* was specific to sesame. The tobacco black shank fungus has been referred as *P*. *parasitica* var. *nicotianae* (Tucker, 1931), *P*. *parasitica* f. sp. *nicotianae* (Herr & Sutton, 1984) and *P*. *nicotianae* f. sp. *nicotianae* (Erselius & Vallavielle, 1984). Ponchet *et al*., 1972) used the name *P*. *nicotianae* f. sp. *parasitica* to refer to the isolates from carnation. While the specificity of *P*. *parasitica* var. *sesami* and *P*. *nicotianae* f. sp. *parasitica* was never confirmed, exceptions to the supposedly specific pathogenicity of black shank fungus on tobacco have been encountered (Tisdale & Kelly, 1926; Nolla, 1928; Ashby, 1928; Bell & Haasis, 1967; Munnecke & Bricker, 1976; Jain *et al*., 1982). Thus, it seems unwise, as far as taxonomy is concerned, to distinguish isolates of *P*. *nicotianae* further based on specific pathogenicity although tobacco pathologists would prefer for communication purposes, a separate name for the tobacco black shank pathogen (Erwin, 1983).

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Table 1. Isolates of *Phytophthora nicotianae* (*P. parasitica*) used

ATCC	Host	Origin	Source
13611	Tobacco	USA	Apple
13612	Tobacco	USA	Apple
13614	Citrus	USA	Klotz A33/1A
15407	Unknown	Unknown	Gallegly M211
15408	Lemon	USA	Gallegly M34
15409	Tobacco	USA	Apple 1143
14310	Tobacco	USA	Gallegly M25
22597	Tobacco	USA	Apple 1156-3-1-9
22598	Tobacco	USA	Apple 1156-3-1-1
26009	Papaya	USA	Ko P-174
26510	Tobacco	USA	Flowers m-229
28302	*Citrus sinensis*	USA	Whiteside PR196
36996	*Gypsophila paniculata*	USA	Engelhard 4093
36997	*Poinsetta pulcherrima*	USA	Engelhard 4146
38212	*Brassaia actinophylla*	USA	Alfierri FTCC 859
38606	Citrus soil	USA	Zentmyer P731
38607	Citrus soil	USA	Zentmyer P991
38812	Strawberry	Japan	Suzui S11
42911	Cocoa	Sao Thome	Erselius 261
46060	Tobacco	USA	Lucas D-Barrow-1
46061	Tobacco	USA	Flowers 228
46062	Tobacco	USA	Bardinelli 3-15R
46063	Tobacco	USA	Bardinelli 3-15T
46293	Rhododendron	USA	Benson 316
46294	Azalea	USA	Benson 327
46732	*Fremontia californica*	USA	Zentmyer P1063
48004	Grapevine	S. Africa	Marais 61
48640	Tobacco	USA	Warner
52638	*Cornus florida*	USA	El-Gholl 080-2886
56197	*Musa* sp.	S. Africa	Thompson 3886
56602	*Piper nigrum*	China	Yu P15a
60439	*Lycopersicum esculentum*	England	CMI 35087
63534	Tomato	USA	CBS 109.17[b]
64535	*Solanum melongena*	Taiwan	CBS 301.29[c]
64536	Tobacco	Taiwan	CBS 305.29[d]

ATCC - Identified by American Type Culture Collection accession number
CBS - Centraalbureau voor Schimmelcultures, Baarn, Netherlands
CMI - Commonwealth Mycological Institute, Kew, Surrey, England

[a] Received as *p. palmivora*

[b] Received as *P. terrestris* (Type)

[c] Received as *P. melongenae* (Authentic)

[d] Received as *P. tabacci* (Authentic)

Table 2. Growth, cultural, hyphal and sporangial characteristics of Phytophthora nicotianae (P. parasitica)

ATCC	Growth at 10C	Culture Appearance	Hyphae	Spiked Swellings	Sporangium(a)			
					Beaked Apex	Length (μm)	Breadth (μm)	L/B
13611	--	irregular,fluffy	uneven	+/-	--	40±3(b)	33±2	1.2±0.1
13612	--	distinctly tufted	very uneven	+/-	++	47±6	32±10	1.5±0.1
13614	+	uniformly fluffy	uniform	+/-	+/-	55±8	40±4	1.4±0
15407	--	uniformly fluffy	uniform	+	--	49±5	39±5	1.3±0
15408	--	tufted	uneven	++	+/-	49±6	38±5	1.3±0
15409	--	tufted, slighlty fluffy	uneven	--	--	43±6	31±4	1.4±0.2
15410	--	uniformly fluffy	slightly uneven	+/-	+/-	45±8	29±4	1.5±0.2
22597	++	irregular, fluffy	uniform	--	--	50±6	34±4	1.4±0.4
22598	--	irregular, fluffy	uneven	--	+/-	38±6	25±2	1.5±0.3
26009	--	irregular, fluffy	uneven	+/-	--	54±3	41±2	1.3±0
26510	--	tufted, fluffy	uneven	+/-	--	45±5	32±3	1.4±0.2
28302	--	irregular, slightly fluffy	uniform	+	--	44±4	34±3	1.3±0
36996	+/-	tufted	slightly uneven	++	--	47±5	37±5	1.3±0
36997	+/-	irregular, fluffy	slightly uneven	+	--	48±5	37±5	1.3±0
38212	--	slightly rosette, not fluffy	uniform	--	--	44±5	29±4	1.5±0
38606	--	tufted, slightly fluffy	uneven	++	+/-	40±6	25±3	1.6±0
38607	--	tufted slightly fluffy	uneven	+	+	42±4	31±2	1.4±0
38812	+/-	uniformly fluffy	uniform	+/-	--	52±7	42±4	1.2±0
42911	+	irregular, fluffy	uneven	--	--	48±5	38±2	1.3±0
46060	--	fluffy	uneven	--	--	52±7	40±5	1.3±0.1
46061	--	tufted, fairly fluffy	very uneven	--	--	47±6	37±4	1.3±0.1

Table 2. (cont'd.)

					Sporangium(a)			
ATCC	Growth at 10C	Culture Appearance	Hyphae	Spiked Swellings	Beaked Apex	Length (µm)	Breadth (µm)	L/B
46062	--	tufted, not fluffy	uneven	--	+/-	44±4	32±3	1.4±0.1
46063	--	irregular, slightly fluffy	uneven	++	--	44±4	34±4	1.3±0.1
46293	+/-	uniformly fluffy	uniform	--	--	44±6	37±4	1.2±0
46294	+/-	tufted, mod. fluffy	slightly uneven	--	--	50±3	39±2	1.3±0.1
46732	--	uniformly fluffy	uniform	+	+/-	42±5	30±4	1.5±0.3
48004	--	tufted	slightly uneven	+/-	--	54±7	40±4	1.4±0.1
48640	++	tufted, not fluffy	uneven	+/-	+/-	43±4	31±3	1.4±0.2
52638	--	tufted	uniform	--	+/-	47±5	34±3	1.4±0.1
56197	++	uniformly fluffy	slightly uneven	+	--	52±6	38±4	1.4±0.1
56602	++	uniformly fluffy	uneven	+	--	38±6	28±5	1.4±0.1
60439	--	Uniformly fluffy	uniform	+	--	43±5	34±3	1.2±0.1
64534	--	tufted, fluffy	uneven	+	--	46±4	41±3	1.1±0.1
64535	--	irregular, tufted	uniform	--	--	50±5	34±3	1.5±0.2
64536	++	uniformly fluffy	uneven	--	+/-	63±6	35±3	1.8±0.2

(a) Produced from mycelial agar discs in water

(b) Mean ± standard error, based on 50 measurements

Table 3. Characteristics of sex organs and chlamydospores of *Phytophthora nicotianae* (*P. parasitica*)

ATCC	Mating Type	Oongium(a) Diam (μm)	Oospore Diam(μm)	Antheridium Length(μm)	Antheridium Breadth(μm)	Chlamydospore Diam(μm)
13611	A2	(No selfed sex organs produced)				37±6
13612	A2	27±3(b)	21±2	9±1	11±2	36±5
13614	A1	25±2	18±2	10±2	11±1	31±4
15407	A2/H	29±2	25±2	11±2	12±1	41±6
15408	A1	27±3	21±2	11±2	12±2	33±7
15409	A1	(No selfed sex organs produced)				25±5
15410	A2	26±3	21±3	12±2	14±2	26±6
22597	A1	30±2	25±2	9±2	12±2	37±5
22598	A1	28±3	23±3	11±2	12±2	31±4
26009	A1	30±2	24±1	8±2	13±1	36±9
26510	A1	28±2	23±2	9±2	13±1	35±5
28302	A2	(No selfed sex organs produced)				32±4
36996	A2	30±1	25±1	9±1	10±1	32±6
36997	A2	30±2	23±2	10±1	12±1	38±8
38212	A2	(No selfed sex organs produced)				30±2
38606	A2	28±2	21±2	10±2	13±2	37±4
38607	A1	28±2	22±2	10±2	11±2	31±5
38812	A2	(No selfed sex organs produced)				33±5
42911	A1	27±2	22±2	10±2	12±1	31±4
46060	A1	29±2	23±2	10±2	14±2	39±7
46061	A2	(No selfed sex organs produced)				34±5
46062	A2	(No selfed sex organs produced)				32±5
46063	A1	27±2	21±5	9±1	12±1	30±6
46293	A2	(No selfed sex organs produced)				34±10
46294	A2	29±1	24±2	9±2	13±1	36±6
46732	A2	26±2	20±1	12±2	13±2	35±6
48004	A1	32±2	26±2	12±2	15±2	33±7
48640	A2	(No selfed sex organs produced)				32±4
52638	A2	30±2	25±2	9±2	12±1	34±7
56197	A2	(No selfed sex organs produced)				36±8
56602	A1	26±2	20±2	12±1	12±1	36±7
60439	A1	(No selfed sex organs produced)				37±7
64534	A2	33±3	28±2	12±1	13±1	31±6
64535	A2	33±3	(aborted)	11±3	13±1	30±6
64536	A2	32	22	10	7	27±10

(a) selfed on membrane X *nicotianae* 38607 (A1) or 38606 (A2)

(b) mean ± standard error based on 50 measurements

Table 4. Characteristics of "*Phytophthora nicotianae* var. *parasitica*" *sensu* Waterhouse (103) recorded chronologically in literature

		Host of	Sporangium			Oogonium	Oospore	Antheridium		Chlamydospore	
Ref.	Synonyms	isolate	Length(µm)	Breadth(µm)	L/B	Diam(µm)	Diam(µm)	Length(µm)	Width(µm)	Diam(µm)	Wall(µm)
103			38(<40)	30	≤1.4(D)	24-26		10	12	<60	3-4(P)
16	*parasitica*	*Ricinus communis*	25-30	20-40		24	19			20-60	P
		Sesamum indicum									
75	*parasitica*	Castor bean	44	23	1.8					31	
5	*parasitica*	Coconut palm	37-40	28-30	1.3-1.4	23	19			36	P
						22	17				
						25	18				
						26	19				
						24	17				
94	*parasitica*	Pineapple	31	26	1.2					27	
53	*parasitica*	Tomato				18					
		Banana				18					
		Cotton				18					
80	*tabacci*	Tobacco	16-58	12-45		26-30	21-24			21-25	1.5-2
6	*parasitica*	Coconut				24	18				
	sec.	Pineapple				24	17				
	microspora	Cotton					28				
							28				
							22				
52	*parasitica*	*Ricinus communis*	40	30	1.3						
	parasitica	Rhubarb	41	30	1.4						
	var. *rhei*		40	31	1.3						
			27	26	1.0						
98	*parasitica*	*Ananas ananas*	50	35	1.4						
		Bryophyllum pinnatum	37	28	1.3						

Table 4. (cont'd.)

		Host of	Sporangium			Oogonium	Oospore	Antheridium		Chlamydospore	
Ref.	Synonyms	isolate	Length(μm)	Breadth(μm)	L/B	Diam(μm)	Diam(μm)	Length(μm)	Width(μm)	Diam(μm)	Wall(μm)
			33	23	1.5						
		Capsicum annuum	41	31	1.3						
			29	21	1.4						
		Catharanthus roseus	37	28	1.3						
			37	29	1.3						
		Citrus sp.	34	24	1.4						
			62	46	1.3						
		Cocos nucifera	60	30	2.0						
		Gossypium barbadense	40	32	1.3						
			43	29	1.5						
			43	32	1.3						
		Grammatophyllum sp.	37	25	1.5						
		Hibiscus sabdariffa	43	26	1.3						
			44	33	1.3						
			42	31	1.4						
		Lilium regale	41	29	1.4						
			49	38	1.3						
			43	32	1.3						
		Lilium sp.	41	30	1.4						
		Lysopersicon	42	33	1.3						
		lycopersici	51	38	1.3						
			37	29	1.3						
			37	30	1.2						
			44	33	1.3						
			46	33	1.4						
			40	29	1.4						

Table 4. (cont'd.)

Ref.	Synonyms	Host of isolate	Sporangium Length(μm)	Sporangium Breadth(μm)	L/B	Oogonium Diam(μm)	Oospore Diam(μm)	Antheridium Length(μm)	Antheridium Width(μm)	Chlamydospore Diam(μm)	Chlamydospore Wall(μm)
		Manihot sp.	35	25	1.4						
		Musa textilis	27	19	1.4						
		Pollia sp.	39	30	1.3						
		Rheum rhaponticum	28	18	1.6						
			42	31	1.3						
		Ricinus communis	32	25	1.3						
			50	40	1.3						
		Solanum melongena	34	24	1.4						
			47	34	1.4						
			41	31	1.3						
			41	30	1.4						
			38	29	1.3						
			42	29	1.9						
		Solanum tuberosum	31	22	1.4						
			35	25	1.4						
		Theobroma cacao	33	25	1.3						
		Vigna sp.	44	34	1.3						
58	*parasitica*	*Piper betle*				38	31	12	14	29	P
						35	28	12	14	33	P
		Ricinus communis	42	27	1.6						
			40	28	1.4						
			41	27	1.5						
17	*parasitica* var. *piperina*	*Piper betle*	36-56	31-36		33	26				
7	*parasitica*	Citrus & Cotton	48	38	1.2	23	19				
47	*parasitica*	Black locust	45	38	1.2					30	P

Table 4. (cont'd.)

Ref.	Synonyms	Host of isolate	Sporangium Length(µm)	Sporangium Breadth(µm)	L/B	Oogonium Diam(µm)	Oospore Diam(µm)	Antheridium Length(µm)	Antheridium Width(µm)	Chlamydospore Diam(µm)	Chlamydospore Wall(µm)
81	*formosana*	Castor bean	36	28	1.3	24-30	19-25	7-13	10-15		
			39	28	1.4						
82	*lycopersici*	Tomato	37	28	1.3	26-33	22-27			23-29	
			36	26	1.4						
81	*ricini*	*Ricinus communis*	38	25	1.6	26-32	24-26			32-40	
102	*parasitica*	Orange	40	28	1.4	32	28			30	P
			48	35	1.4	30				30	P
73	*parasitica*	Tomato	41	30	1.4	50(a)	33(a)	None(a)		31	P
										31	P
61	*parasitica*	Belladonna	38	31	1.2	23	20				
18	*parasitica*	Potato	20-63	15-48		31	26			18-43	P
24	*parasitica*		43	25	1.6	30	27	9	12	34	
43	*parasitica*	Tomato	47	31	1.5					30	
			45	37	1.2					32	
			41	28	1.5					36	
			29	24	1.2					29	
			38	31	1.2					37	
			42	36	1.2	28				36	
			48	46	1.0					28	
			29	26	1.1					41	
			43	37	1.2					35	
			39	33	1.2					30	
			39	36	1.1					36	
			33	31	1.1					39	
		Eggplant	37	29	1.3	26				30	
			33	29	1.1	25-28				40	

Table 4. (cont'd.)

Ref.	Synonyms	Host of isolate	Sporangium			Oogonium	Oospore	Antheridium		Chlamydospore	
			Length(µm)	Breadth(µm)	L/B	Diam(µm)	Diam(µm)	Length(µm)	Width(µm)	Diam(µm)	Wall(µm)
			31	30	1.0	22-28				28	
			29	26	1.1					37	
			36	28	1.3	31				30	
			37	31	1.2					36	
			37	31	1.2					29	
			29	27	1.1					28	
			35	29	1.2					31	
			33	28	1.2	22				30	
			33	28	1.2	28				35	
		Sesamum	30	30	1.0					34	
			23	20	1.2					28	
			35	32	1.1					30	
			47	41	1.1					41	
			30	26	1.2					27	
			32	30	1.1	32				30	
			32	26	1.2					29	
			29	24	1.2					38	
			39	33	1.2					41	
			28	25	1.1					25	
			32	22	1.5					38	
			29	29	1.0	21				41	
		Pistachio	30	24	1.3	29				31	
			41	38	1.1					29	
106	*parasitica*	Tomato				18-30	12-25			20-60	
39	*parasitica* var. *sesami*	*Sesamum*	39	33	1.2						

Table 4. (cont'd.)

Ref.	Synonyms	Host of isolate	Sporangium Length(µm)	Sporangium Breadth(µm)	L/B	Oogonium Diam(µm)	Oospore Diam(µm)	Antheridium Length(µm)	Antheridium Width(µm)	Chlamydospore Diam(µm)	Chlamydospore Wall(µm)
83	*parasitica*	*Bryophyllum*	41	32	1.3					33	
		Dianthus	49	38	1.3					29	
		Sesamum								28	
		Solanum melongena								30	
8	*parasitica*	Boxwood	42	31	1.3	24	19	12	14		
						24	19	14	12	32	
						26	22	14	13	29	
		Citrus & Ivy	38	28	1.4						
			36	27	1.3				30		
			43	32	1.3				32		
			38	29	1.3				29		
44	*parasitica*	Pistachio & Rosemary	34-56	26-45	1.2-1.4	23-24		11-12			
22		*Solanum tuberosum*	34	26	1.3	34	26	11	11	30	
		Ailanthus altissima	41	30	1.4	29		12	13	29	
		Dianthus caryophyllus	41	32	1.3	25	22	16	15	31	
		Malus sylvestris	35	27	1.3	27	21	12	12	31	
		L.esculentum	43	32	1.4						
		Sesamum indicum	40	30	1.4	27	21	13	12		
						29		13	12	29	
		Araucaria araucana	40	29	1.4	30		13	13	32	
		Solanum melongena	43	27	1.6						
		Citrus sp.	47	34	1.4	31	24	13	12		
			39	30	1.3						
		Washingtonia filifera	33	25	1.3	26	25	12	12	19	
		Nicotiana sp.	37	25	1.5	29		13	12	29	
48		Strawberry	40	29	1.4						

Table 4. (cont'd.)

Ref.	Synonyms	Host of isolate	Sporangium Length(μm)	Sporangium Breadth(μm)	L/B	Oogonium Diam(μm)	Oospore Diam(μm)	Antheridium Length(μm)	Antheridium Width(μm)	Chlamydospore Diam(μm)	Chlamydospore Wall(μm)
			38	28	1.3	23		12	12		
26		Peperomia	35	30	1.2					25-40	
99	*parasitica*		44-50	29-32	1.3-1.4	30	28	8	11	28	
66					<1.6	<28-40	<20-25			<25-35	
13	*parasitica*	*Phalaenopsis*	48	38	1.3	18		16	12	25-40	
9	*parasitica*	Citrus	38-50	30-40						<60	
56		Strawberry	43	35	1.2			13	14		
				45		39	1.2	13	14		
			44	35	1.3	27	18				
			44	36	1.2				14	14	
112	*nicotianae*	*Agave sisalana*	58	46	1.3(ND)	24	21	13	12	21	
		Piper nigrum	47	37	1.4(ND)					28-40	
		Rheum emodi	52	42	1.2(ND)					33-47	
		Ricinus communis	55	47	1.3(ND)					30-42	
		Solanum melongena	47	40	1.2(ND)					25-44	
			54	41	1.3(ND)					30-44	
		Stephania sinica	41	34	1.3(D)					22-46	
100		Citrus	43	34	1.6	28				28	
65	*nicotianae*	Golden-fruit palm	48	37	1.3	28	22	10	13	39	
45	*nicotianae*		44	33	1.3	32	27			30	
69		Lithospermum	40	32	1.2-1.4	27	23	11	12		
14		*Lilium*	49	32	1.5						
64		Sesame	45	32	1.4		19			32	P
4		Soil	38	30	1.3	26	12	9			

D = Deciduous; ND = Nondeciduous; P = Pigmented (yellowish to brown); *Sex organs questionable; (not included in analysis)

Table 5. Characteristics of "*Phytophthora nicotianae* var. *nicotianae*" *sensu* Waterhouse (103) recorded chronologically in literature

Ref	Synonyms	Host of isolate	Sporangium			Oogonium	Oospore	Antheridium		Chlamydospore	
			Length(µm)	Breadth(µm)	L/B	Diam(µm)	Diam(µm)	Length(µm)	Width(µm)	Diam(µm)	Wall(µm)
103			45(>40)	36	1.3(ND)	28-30	24	10-16	10	20-40	1.5 (NP)
11	*nicotianae*	Tobacco	36	25	1.4	19	15				
79	*melongenae*	Eggplant	42	34	1.3	18-23 x 20-24	17-21	10-14	12-16	25-42	P
79	*allii*	Onion	49	37	1.3	21	17	10-14	8-18	P	
87	*terrestris*	Tomato	43	31	1.4	22	20			34	
75	*nicotianae*	Tobacco	38	30	1.3					29	
5	*terrestris*	Tomato				24	19				
	parasitica	Tobacco	55	48	1.2	25	19				
40	*terrestris*	Tomato, eggplant, pepper	31	41	1.3		21			25	
28	*parasitica* var. *rhei*	Rhubarb	41	31	1.3		24			33	P
68	*melongenae*	Eggplant	35	28	1.2	24-32	16-24			29	NP/P
94	*nicotianae*	Tobacco	34	26	1.4					25	P
			38	29	1.3					23	P
			37	25	1.5						
53	*nicotianae*	Tobacco	46	33	1.4						
6	*terrestris*	Tomato				19					
						19				29	
						15					
	parasitica	Tobacco				30	26	8-10	12-14		
	sec. *macrospora*					33	26	9	15		
67	*nicotianae*	Tobacco	47	37	1.2					35	
			50	39	1.5					35	

Table 5. (cont'd.)

		Host of	Sporangium			Oogonium	Oospore	Antheridium		Chlamydospore	
Ref	Synonyms	isolate	Length(µm)	Breadth(µm)	L/B	Diam(µm)	Diam(µm)	Length(µm)	Width(µm)	Diam(µm)	Wall(µm)
			47	39	1.2					40	
			42	33	1.3					31	
52	*terrestris*	Tomato	41	32	1.3						
98	*parasitica*	Tobacco	35	25	1.4	29	25			29	
	var. *nicotianae*		41	32	1.3	29	25			24	
			40	29	1.4	26	21			21	
18	*parasitica*	*Piper betle*	36-56	31-36		33	20				
	var. *piperina*										
43	*parasitica*	Tobacco	30	26	1.2	33-34				30	
			32	26	1.2					29	
			43	36	1.2					35	
			42	36	1.3					33	
38	*parasitica*	Tobacco					23				
3	*parasitica*	Tobacco					24				
	var. *nicotianae*										
83	*parasitica*	Tobacco								28	
	var. *nicotianae*										
	parasitica	Rhubarb	45	34	1.3					35	
	var. *rhei*										
71	*parasitica*	*Annona squamosa*	40	19		21				28	
	var. *macrospora*										
110		*Agave*			1.3 (ND)						
91		*Anacardium*	63	44	1.4 (ND)					35-37	
66					<1.6	28-40	20-30			25-35	
111		*Premontia*	39	31	1.3(ND)		28	22	11	35	1.5
36		Tomato	30-70	23-45	1.2-1.4		25-35		8-10	10-17	

Table 5. (cont'd.)

Ref	Synonyms	Host of isolate	Sporangium Length(μm)	Sporangium Breadth(μm)	L/B	Oogonium Diam(μm)	Oospore Diam(μm)	Antheridium Length(μm)	Antheridium Width(μm)	Chlamydospore Diam(μm)	Chlamydospore Wall(μm)
19		Tomato	36	26	1.4		25-28	23-27			
112	*nicotianae*	Tobacco	42	34	1.3					21-37	
37		*Solanum melongena*	42	31	1.4					23	
64		Sesame	45	32	1.4	19				32	
4		Soil	42	32	1.4	25		13	11		

P = Pigmented (yellowish to brown) NP = Non-pigmented

ND = Non-deciduous

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CHAMONIXIA BISPORA SP. NOV. (BOLETALES) FROM CHINA

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ABSTRACT

An undescribed species, Chamonixia bispora sp. nov., from Guangdong, China, is described and illustrated, with detailed comparison with the other described species of the genus. This Chinese species is readily distinguished from the other species by a combination of the following characters: small short basidia bearing 2 spores (15-21 x 10-12 µm) with 3-4 longitudinal ridges, no columella, and peridium cyanescent when bruised or cut in the fresh state. A key to the Chinese species of Chamonixia is provided.

Key words: Chamonixia bispora sp. nov.; Boletales; taxonomy; China

During our investigation of Chinese hypogeous fungi, we came across an interesting collection deposited under the name of Gautieria graveolens Vittadini in the mycological herbarium of Guangdong Institute of Microbiology, Guangzhou. After careful studies, we found it to be a species belonging to the genus Chamonixia Rolland. A literature survey revealed that the genus has already been recorded with a single species, C. caespitosa Rolland, in China before (Eckblad & Ellingsen, 1984). This species was collected by H. Smith, a Swedish botanist who travelled to China three times to collect many specimens of higher plants and some higher fungi, in Sichuan in 1922. We have not examined the material which is deposited in UPS, but according to the authors' descriptions and the scanning electron microscopy of the spores, the present Chinese collection apparently differs from Smith's collection.

Since Rolland (1899) erected the genus Chamonixia typified by C. caespitosa, about a dozen species have been described in the genus (Rolland, 1899; Corner & Hawker, 1953; Smith & Singer, 1959; Beaton et al., 1985). It is distributed in Europe (Lange & Hawker, 1951; Kotlaba, 1971; Gross, 1974; Haeggstrom, 1987), North America (Dodge & Zeller, 1934; Smith & Singer, 1959), Australasia (Beaton et al., 1985; Corner & Hawker, 1953; Cribb, 1958; Cunningham, 1944) and China (Eckblad & Ellingsen, 1984). The genus is characterized by having almost globose whitish basidiomata with a peridium cyanescent when bruised or cut, and short clavate basidia bearing ellipsoidal spores with several longitudinal ridges (Beaton et al., 1985; Rolland, 1899; Smith and Singer, 1959). It is considered to belong to the Boletales (Jülich, 1981; Beaton et al., 1985). By comparisons with all published species of the genus, the present Chinese collection is apparently distinct and represents a species new to science.

The following descriptions are based on our observations and field notes accompanying the specimen. In our microscopic observations, the colours and measurements were obtained from material mounted in 5% KOH unless stated otherwise. For observations using the scanning electron microscope, material from a basidiome was rehydrated on a clean glass slide and stuck onto an adhesive layer on a small clean cover slip, then coated with gold and observed using a Hitachi S570 SEM.

KEY TO THE CHINESE SPECIES OF CHAMONIXIA

Columella percurrent; basidia 4-spored; spores with
    8 or more longitudinal ridges .... *C. caespitosa*
Columella absent; basidia 2-spored; spores with
    3-4 longitudinal ridges .... *C. bispora*

CHAMONIXIA BISPORA B.C.Zhang & Yu, sp. nov. Figs 1-4

Basidiomata subglobosa vel applanata, 1.1-2 cm lata; peridium album vel griseolo-brunneum, cyanescens ubi contusum; gleba brunneola vel fusca, cyanescens et viscida ubi secta, loculis minutis irregularibus composita; columella nulla. Sporae 15-21 x 10-12 µm, symmetricae, ellipsoideae vel breviter fusiformes, pallide brunneae, 3-4 costis praeditae. Basidia clavata vel subcylindrica, 2-sporigera. Trama hymenophoris 80-160 µm crassa, hyalina, gelatinosa. Peridiopellis hyphis parallelibus repentibus composita.

Ad terrum in sylvis frondosis.

Etymology: *bi* (Latin, two) and *spora* (Latin, spore), referring to each basidium bearing two spores.

Basidiomata epigeous, subglobose to flattened, 11-20 mm in the largest dimension, fleshy when fresh, drying firm, astipitate, with basal rhizomorphic attachment. Peridium very thin in section, white to pale greyish brown when fresh, becoming deep blue when bruised or in Melzer's reagent, drying pale greyish brown, ochraceous to medium brown, no colour change when stained in KOH. Gleba pale brown when young, brown to dark brown at maturity, becoming deep blue and sticky on cut surface when fresh, with numerous small chambers, 1-4 per mm, empty or filled with spores. Columella absent. Sterile base present, small. Tramal plates partly or fully gelatinized, 150-240 µm thick, composed of a broad hymenophoral trama and poorly developed subhymenial layers. Clamp connexions not seen. Spores symmetric, 15-21 x 10-12 µm including ridges, ellipsoidal to short-fusoid, obtuse at apex but occasionally acute, pale brown in KOH, brown to reddish brown in Melzer's reagent, with thickened wall about 1 µm, ornamented with 3-4 longitudinal ridges up to 2 µm high but usually lower, appearing as an irregular triangle or square profile when viewed from pole; hilar appendix conspicuous, 0.5-2 µm in length, often with terminal sterigmal appendages; with 1-2 droplets. Basidia clavate to subcylindrical, short, bearing 2 sterigmata, sometimes up to 5 µm high, readily collapsing. Subhymenial layers poorly developed, 10-20 µm thick, pseudoparenchymatous. Hymenophoral trama variable, 80-160 µm broad, composed of loosely interwoven

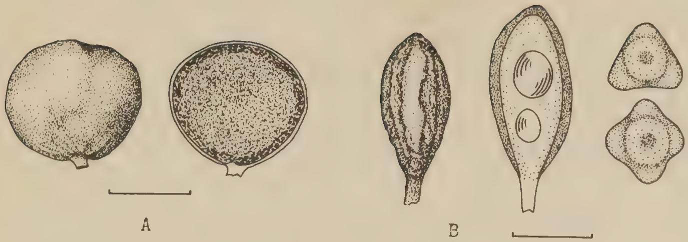
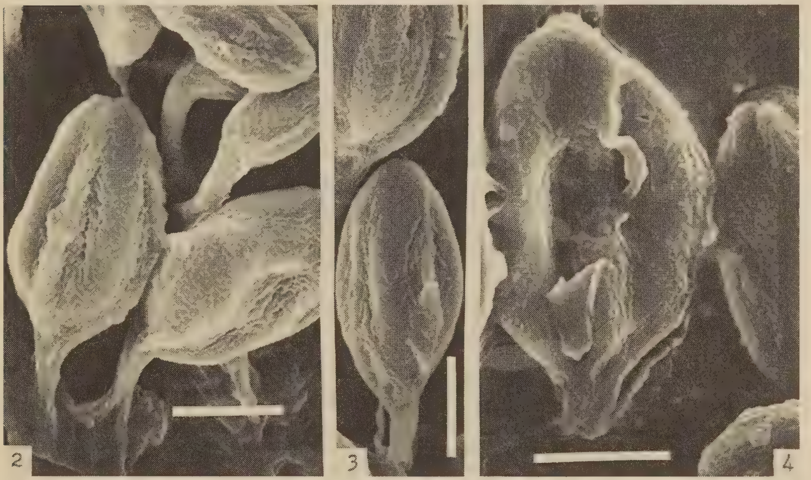


Fig.1. Basidiomata and basidiospores of *Chamonixia bispora*: A. Habit and section (bar=10 mm). B. spores of different views (bar=10 µm).



Figs 2-4. Basidiospores of *Chamonixia bispora* (SEM, holotype). (bar= 5 µm). Figs 2-3 showing spore shape and spore ornamentation. Fig.4 showing broken ridge of the spore.

hyaline hyphae 2-4 µm diam, gelatinized. Peridiopellis 160-240 µm thick, a repent epicutis, composed of thin walled parallel hyphae 2-3 µm diam.

HOLOTYPE: CHINA: Guangdong Prov., Dinghu Mountain Natural Reserve, near Qing Yun Temple, solitary on the ground in broad-leafed woods, leg. Wang You-zao, Zhen Wan-ling, Li Jian-qing, 13 X 1982 (GDIMH 5688). The type specimen is deposited in the Mycological Herbarium of Guangdong Institute of Microbiology, Guangzhou (GDIMH). Some basidiomata are partly eaten by insects.

This Chinese epigeous species possessing basidiomata with a whitish peridium cyanescent when bruised in the fresh state and short basidia bearing spores with longitudinal ridges, clearly belongs to the genus _Chamonixia_, although most species in this genus are hypogeous. _C. bispora_, characterized by having 2-spored small basidia, larger spores (15-21 x 10-12 µm) with 3-4 regular, longitudinal ridges, is readily distinguished from other species.

C. bispora is most similar to another species, _C. caespitosa_, which also occurs in China, in gross morphology and spore size. But the former differs from the latter in its absence of columella, 2-spored basidia and spore ornamentation (Eckblad & Ellingsen, 1984). _C. bispora_ is also similar to _C. octorugosa_ Corner & Hawker and _C. caespitosa_ in spore size, but the latter has spores with 8 or more ridges and 4-spored basidia (Corner & Hawker, 1953). _C. bispora_ differs from _C. mucosa_ (Petri) Corner & Hawker, _C. pachydermis_ (Zeller & Dodge) Beaton, Pegler & Young, and _C. vittatispora_ Beaton, Pegler & Young in its larger spores and usually has fewer ridges on the spores, and 2-spored basidia (Beaton et al., 1985). There are three more species occurring in North America, which are distinct in their very irregular spore ornamentations (Smith & Singer, 1959), totally different from _C. bispora_. In _Chamonixia_, spore size and spore ornamentation are generally considered to be the main characters used to separate the species (Smith & Singer, 1959; Beaton et al., 1985).

Because of the similarity of spore ornamentations, _Chamonixia_ is sometimes considered to be synonymous with _Gautieria_ Vitt. (Dodge & Zeller, 1934; Cunningham, 1944; Cribb, 1958), but their longitidinal ridges are formed in different ways (Beaton et al., 1985). Our observations using SEM provide more evidence for their point of view. The ridges on spores of _C. bispora_ are formed by an undulation of the episporial wall (i.e. outer layer), and are loosely connected with the inner walls and easily broken, exposing the inner walls (Fig. 4).

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中文摘要

本文描述采自广东的一新种双孢卡氏腹菌 *Chamonixia bispora* B.C.Zhang & Yu sp. nov.，并与该属已描述的种进行了详细的比较。双孢卡氏腹菌的主要特征为担子果白色至灰褐色，新鲜时受伤变蓝，无中轴；担子小而短，每个担子上着生两个孢子，孢子15-21 X 10-12μm，表面具 3－4 条纵肋。文中附有卡氏腹菌属中国种的检索表。

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ASCOSPARASSIS HEINRICHERI FROM VENEZUELA: AN EXTENDED DISTRIBUTION.

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ABSTRACT

A brief review of the genus *Ascosparassis* (Pezizales) is given and a collections of the only known species, *A. heinricheri*, is reported for the first time from the Western Hemisphere. A photograph of *A. heinricheri* in fresh condition is provided.

The purpose of this brief note is to report on a collection of *Ascosparassis heinricheri* (Bres.) by D. Pfister from Venezuela. The previous collections of this taxon have been made in Asia. The genus *Ascosparassis* was described by Kobayasi (1960), who based his description on a collection made by Shimizu from northern Honshu. He named the fungus *Ascosparassis shimizuensis* in honor of the collector and described it as a member of the Sclerotiniaceae, a family in the Leotiales. Kobayasi stated that the fungus "has the beautiful appearance resembling cauliflower or *Sparassis* with rosy tint." Korf (1963) studied additional collections of *A. shimizuensis* from Java and concluded that the fungus had operculate asci and referred it to the Pezizales placing it near *Otidea*. He (1973) later abandoned the genus *Ascosparassis* and placed the only species in *Otidea*. Based on the color, as judged by watercolor illustrations by van Overeem, Korf (1963) compared it with *Acervus aurantiacus* Kanouse, an orange fungus. In the course of tracing names of species referred to the genus *Midotis* and *Wynnea*, Pfister (1979) found an older name for this species, *Midotis heinricheri* Bres. (also from Java), and transferred the species to *Ascosparassis* which he recognized as a monotypic genus in the Pyronemataceae.

With reference to these few publications, the record of the genus and its single species is largely covered. Previous collections were from Indonesia and Japan (see Korf 1963) and at least one collection is known from China (Longtou Mts., Guizhon, Sept. 12, 1986, col. Liu Meihauai, det. Cao, Mycological Herbarium of Shanxi University no. 760 and FH).

Recently the junior author collected *Ascosparassis* in the north coastal mountains of Venezuela. This collection constitutes the first report of the species from the Americas. The collection (Estado Aragua, along road from Maracay to Choroni, on hardwood in soil, among bamboo, 20 July 1987, NY, FH, VIA, A) was photographed in the field. The photograph is reproduced here as figure 1. The collection agrees closely with the Asian material.

The diagnostic characteristics of the species are the sparassoid growth of the ascomata with numerous flattened upright branches; the small (4.5-5.5 x 3-4 μm) biguttulate ascospores; the broad hooked, curved and deformed paraphyses; and the thick outer excipulum made up of globose to angular cells giving rise to pustules on the outer surfaces. When fresh, the ascomata of the Venezuelan collection were 7-8 cm tall, orange, and had a chantarelle-like odor.

There are some variations in the descriptions of the species in the literature. In the first description of *A. shimizuensis*, it was said that the collection was pale rosy colored. All other collections seem to be yellow or yellowish. The isotype material of *A. heinricheri* (FH-Pat.) retains its yellow pigments even dried. It may also be noteworthy that both the holotype of *A. shimizuensis* and the Venezuelan collection were made among bamboo shrubs.

Acknowledgements

The junior author thanks Dra. Ninoska Pons (VIA) for logistical support in Maracay and support from NSF grant #BSR-860024. The authors wish to thank Dr. Richard P. Korf for reviewing the manuscript.

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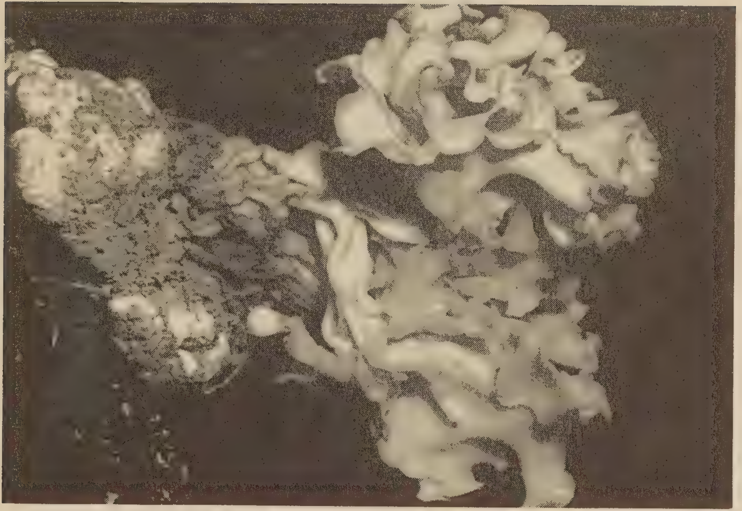

Figure 1. Ascosparassis heinricheri from Venezuela, natural size. Specimen in NY.

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REDISPOSALS AND REDESCRIPTIONS IN THE MONOCHAETIA - SEIRIDIUM, PESTALOTIA - PESTALOTIOPSIS COMPLEXES. IX. ON THE STATUS OF PESTALOTIA EUPYRENA, PESTALOTIA GASTROLOBI AND PESTALOTIA VENETA.

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Pestalotia eupyrena and *Pestalotia gastrolobi* are redisposed in *Pestalotiopsis*. ***Seiridium venetum* comb. nov.** is proposed to accommodate *Pestalotia veneta*, and *Seiridium corni* is considered its synonym.

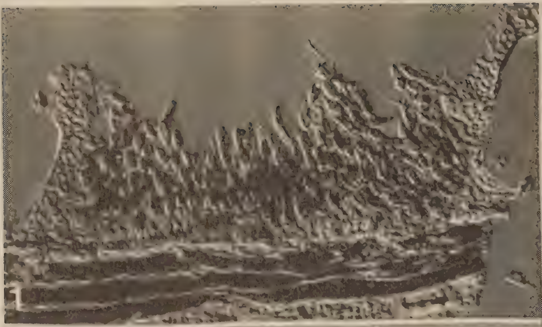
15. *Pestalotia eupyrena* Tassi
Boll. Lab. Ort. Bot. R. Univ. Siena 2: 105, 1899.
On pods of *Bossiaea ensata*, New Holland, Sydney, Australia; and

16. *Pestalotia gastrolobi* Tassi
Boll. Lab. Ort. Bot. R. Univ. Siena 3: 101, 1900.
On dead or withering legumes of *Gastrolobium boormanii*, New South Wales, Australia.

Guba (1961) accepted both fungi as good species of *Pestalotia* in the section 'quadriloculatae'. Study of the holotype specimens in SIENA, however, shows both taxa to be congeneric with *Pestalotiopsis maculans* (Corda) Nag Raj. They are transferred to *Pestalotiopsis*, redescribed and illustrated in Figs. 1-8 and 9-17 respectively. A key is given to all 3-septate species of *Pestalotiopsis* known to-date.

Pestalotiopsis eupyrena (Tassi) Nag Raj **comb. nov.** Figs. 1-9
≡ *Pestalotia eupyrena* Tassi, Boll. Lab. Ort. Bot. R. Univ. Siena 2: 105, 1899.

Fructicolous, occurring on the outer surface of the pod. *Conidiomata* stromatic, pycnidioid, scattered to gregarious, rarely confluent, innate erumpent, appearing as pulvinate or conoid, dark brown to black pustules, angular, orbicular or irregular in outline, broadly conical, 250-400 µm wide, 100-150 µm deep, unilocular, glabrous; basal stroma and lateral walls of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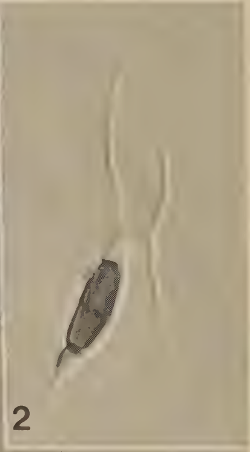
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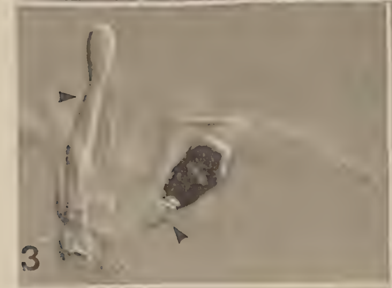
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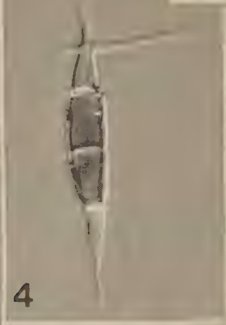
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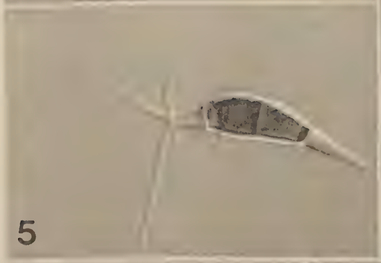
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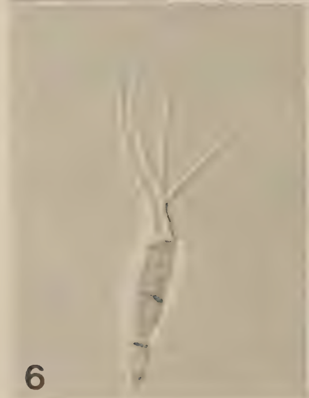
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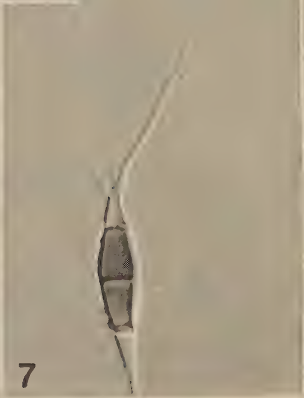
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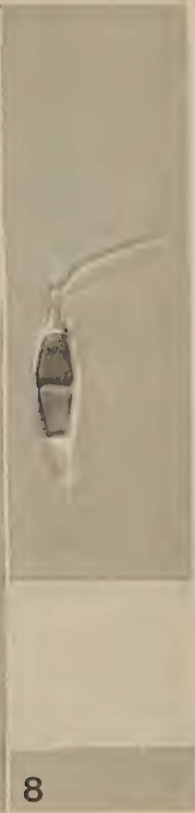
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Figures. 1-8. *Pestalotiopsis eupyrena* ex holotype in SIENA. Fig. 1. v.s. of a conidioma; Figs. 2, 4-8. Mature conidia; Fig. 3. Conidiogenous cells with developing conidia; Fig.1, X 165; Figs. 2-8 X 700.

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subhyaline 'textura angularis', 20-30 µm thick. *Conidiophores* lining the cavity of the conidioma, sparsely septate only at the base and up to 40 µm long, or reduced to conidiogenous cells, hyaline, smooth, invested in mucus. *Conidiogenous cells* phialidic, cylindrical to subcylindrical and 16-25 X 1.5-2 µm, or ampulliform to lageniform and 5.5-15 X 2.5-5 µm, with up to 4 percurrent proliferations. *Conidia* blastic-phialidic, elliptic-fusiform, 3-septate, 22-29 X 7-7.5(-8) [x̄ = 25.5 X 7.2] µm, bearing appendages; basal cell obconic with a truncate base bearing minute marginal frills, subhyaline to hyaline, thin- and smooth-walled, 5(-6.5) µm long; median cells 2, doliiform, with thick walls, verrucose, brown and concolorous, together 12-17.5 [x̄ = 14.8] µm long (second cell from the base 6-9.5 [x̄ = 7.5] µm; third cell 6-8 [x̄ = 7.3] µm); apical cell conical, subhyaline to hyaline, thin- and smooth-walled, 4-6 [x̄ = 5] µm long; appendages tubular, attenuated, slender, flexuous; apical appendages 3-5, simple or branched, arising in an apical crest but each inserted at a different locus on the apical cell, 26-53 [x̄ = 40] µm long; basal appendage usually present, single, unbranched, centric, 7-12 [x̄ = 10] µm long; mean conidium length/width ratio = 3.5:1.

Habitat: On legumes of *Bossiaea ensata.*

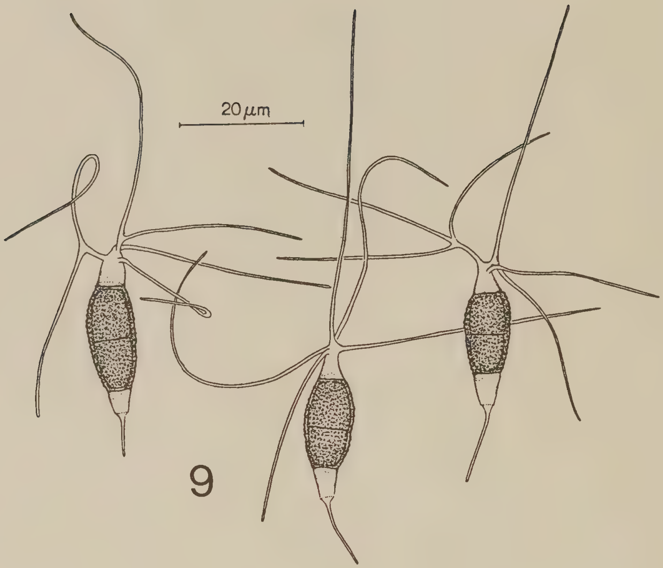
Specimen examined: SIENA [Holotype], New Holland, Sydney, New South Wales, Australia.

Known distribution: Australia.

Teleomorph: Unknown.

Pestalotiopsis gastrolobi (Tassi) Nag Raj **comb. nov.** Figs. 10-19
≡ *Pestalotia gastrolobi* Tassi, Boll. Lab. Ort. Bot. R. Univ. Siena 3: 101, 1900.

Fructicolous. *Conidiomata* stromatic, pycnidioid to acervuloid, scattered, rarely gregarious and confluent, intra-peridermal in origin, oval to orbicular in outline, subglobose to conical or cupulate in sectional view, 60-120 µm wide, 40-70 µm deep, unilocular, glabrous, dark brown to black, covered with black, pulverulent masses of conidia; dehiscing by a break in the overlying host tissue; basal stroma and lateral peridium 10-15 µm and a few cells thick, of a loose 'textura globulosa,' cells at the outer edge of the conidioma pale brown to brown, paler to hyaline in the inner area. *Conidiophores* arising all around the cavity of the conidioma, sparsely septate and branched only at the base and up to 40 µm long, or reduced to conidiogenous cells, hyaline, smooth, invested in mucus. *Conidiogenous cells* phialidic with minute periclinal thickenings in the collarette zone, ampulliform to lageniform and 6-10 X 2.5-3.5 [x̄ = 8 X 3] µm, or cylindrical to subcylindrical and 15-21 X 1.5-2.5 [x̄ = 17 X 1.7] µm, without percurrent proliferations. *Conidia* blastic-phialidic, fusiform to ellipsoid, 3-septate, 17-24 X (5-)6-7(-7.5) [x̄ = 20 X 6.5] µm, bearing



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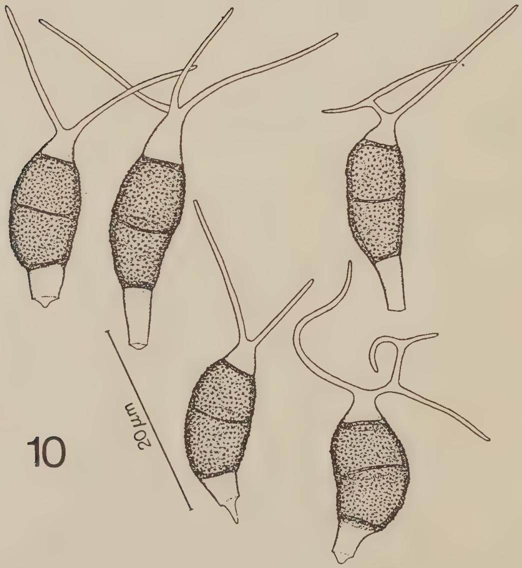

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Fig. 9. Mature conidia of *Pestalotiopsis eupyrena*; Fig. 10. Mature conidia of *Pestalotiopsis gastrolobi.*

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appendages; basal cell elongated obconic, subhyaline to hyaline, thin- and smooth-walled, 4-5.5(-6) [x̄ = 4.7] µm long; median cells 2, doliiform with thick, verrucose walls, honey brown and concolorous, ± equal, each cell 5-7 [x̄ = 6] µm long, together 10.5-14 [x̄ = 11.5] µm long; apical cell short conical, subhyaline to hyaline, with thin, smooth walls, 3-4.5 [x̄ = 3.7] µm long; appendages tubular, attenuated, coarse, flexuous; apical appendages 2-3, mostly simple, occasionally one of them irregularly branched, arising in an apical crest, but each inserted at a different locus on the apical cell, 7-22 [x̄ = 14] µm long; basal appendage mostly lacking, but when present, single, unbranched, centric, 1-1.5 µm long; mean conidium length/width ratio = 3:1.

Habitat: On dead or withering legumes of *Gastrolobium boormanii.*

Specimen examined: SIENA [Holotype], Sydney, New South Wales, Australia.

Known distribution: Australia.

Teleomorph: Unknown.

Key to 3-septate species of *Pestalotiopsis.*

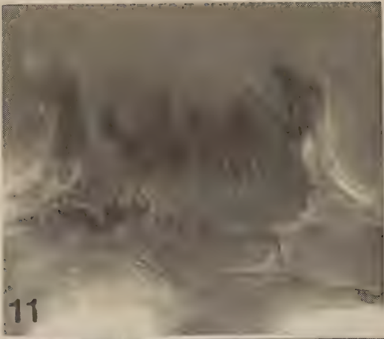
A. Apical appendages 26-53 µm long; basal appendage usually present and up to 12 µm long; mean conidium length/width ratio = 3.5:1; second cell of conidium from base slightly longer than third cell . . . . *P. eupyrena*
A. Apical appendages up to 25 µm long; basal appendage mostly absent, but when present up to 4.5 µm long . . . . B

B. Median cells prominently verrucose, honey brown, together 11.5 µm long on average, equal in length; mean conidium length/width ratio = 3:1 . . . . *P. gastrolobi*
B. Median cells minutely verruculose, pale brown C

C. Conidia 7-9 µm wide; two median cells unequal, together 12-17 µm long; apical appendages 2-4, simple, or one occasionally branched, (-6.5)10-25 µm long; basal appendage, when present, up to 4.5 µm long . . . . *P. citrina*
C. Conidia 5-6(-6.5) µm wide; two median cells ± equal, together 9-11 µm long; apical appendages usually 3, unbranched, 10-15(-17) µm long; basal appendage, when present, up to 3 µm long . . . . *P. besseyi*

17. *Pestalotia veneta* Saccardo
Michelia 1: 92, 1877.
On *Cornus sanguinea*, Selva, Italy, IX.1873.

Guba (1961) accepted Allescher's (1902) redisposal of the fungus as *Monochaetia veneta* and included three other collections under the binomial. He also accepted *Pestalotia corni* Allescher in *Pestalotia* in the section 'sexloculatae', although Allescher (1890) had reported that it approaches *Pestalotia veneta.* He does not mention having examined type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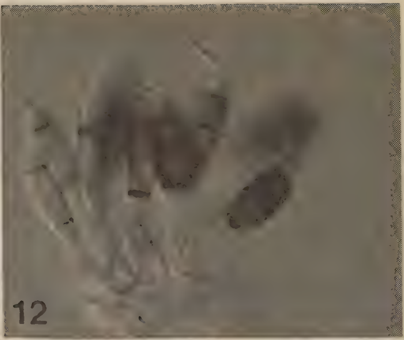
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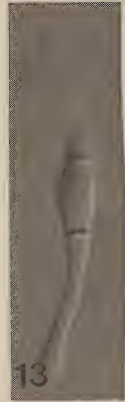
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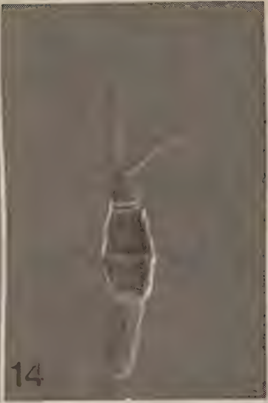
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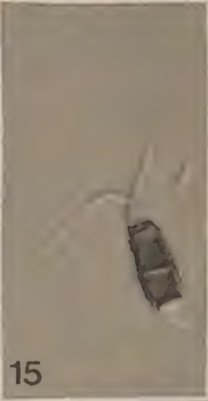
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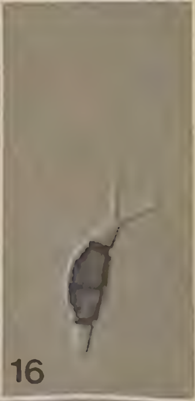
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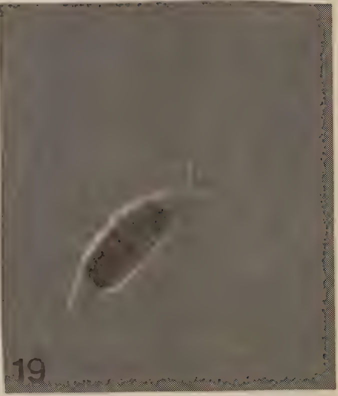
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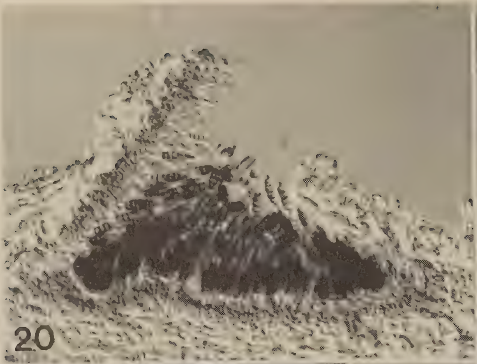
Figs. 11-19. *Pestalotiopsis gastrolobi* ex holotype in SIENA. Fig. 11. v.s. of a conidioma; Figs. 12 & 13, Conidiogenous cells with developing conidia; Figs. 14-19. Mature conidia. Fig. 11, X 420; Figs. 12, 15 & 16, X 700; Figs. 13, 14, 17-19, X 880.

specimens and his descriptions of the two species appear to be literal translations of the originals. Sutton (1969) published *Seiridium corni* (Allescher) Sutton, based on his study of a possible topotype specimen of *Pestalotia corni* in HBG. I had the opportunity to examine the holotype specimen of *P. veneta* in PAD, and other collections of *Seiridium corni* examined by Sutton (1969). As a result of these studies, I find that *P. veneta* and *S. corni* are conspecific and that both belong in *Seiridium* Nees : Fries. The fungus is redescribed with the correct nomenclator as follows:

Seiridium venetum (Saccardo) Nag Raj **comb. nov.** Figs. 20-30
≡ *Pestalotia veneta* Saccardo, Michelia 1: 92, 1877.
≡ *Monochaetia veneta* (Saccardo) Allescher in Rabenhorst, Krypt. Flora 1, Abt. 7: 668, 1902.
= *Pestalotia corni* Allescher, Bot. Centralbl. 42: 106, 1890.
≡ *Seiridium corni* (Allescher) Sutton, Can. J. Bot. 47: 2091, 1969.

Caulicolous, corticolous. *Conidiomata* stromatic, pycnidioid, scattered to gregarious, occasionally confluent, intraperidermal in origin, erumpent, appearing as conoid, black pustules, orbicular to oval in outline, ultimately crateriform in sectional view, 300-700 µm wide, 200-400 µm deep, unilocular with the locule irregularly divided, glabrous, dark brown; basal stroma and lateral tissue of an outer, loose, subhyaline 'textura intricata', and an inner more compact 'textura globulosa' to 'textura angularis' with an external layer of thick-walled, brown cells, and an internal layer of paler cells; basal stroma up to 30 µm thick, lateral tissue 50-60 µm thick; dehiscence by a split in the overlying host tissue. *Conidiophores* lining the cavity of the conidioma, septate, irregularly branched, hyaline, smooth-walled, 60-90 µm long, invested in mucus. *Conidiogenous cells* phialidic with minute periclinal thickenings in the collarette zone, cylindrical, occasionally lageniform, hyaline, smooth-walled, 7-25 X 1-2.5 [$\bar{x}$ = 15.2 X 1.7] µm, with up to 2 percurrent proliferations, occasionally resulting in new conidiophores or conidiogenous cells at a higher level. *Conidia* blastic-phialidic, fusiform to ellipsoid, straight or somewhat bent, 5-septate, 18-28 X (6.5-)7-8.5 [$\bar{x}$ = 23.5 X 7.7] µm, bearing appendages; basal cell obconic with a truncate base, mostly hyaline but subhyaline near the septum, smooth-walled, 3-3.5 [$\bar{x}$ = 3.2] µm long; 4 median cells doliiform, unequal, brown, wall thick and smooth, together (12.5-)17-19(-21.5) [$\bar{x}$ = 18] µm long (second cell from base (4-)5-6 [$\bar{x}$ = 5.5] µm; third cell 3-4.5 [$\bar{x}$ = 3.7] µm; fourth cell (2.5-)3-4 [$\bar{x}$ = 3.5] µm; fifth cell (3-)5-7.5 [$\bar{x}$ = 5.5] µm); apical cell narrow conical, mostly hyaline, subhyaline near the septum, smooth-walled, 2-4 [$\bar{x}$ = 3] µm long; appendages tubular, attenuated, flexuous; apical appendage single, simple or branched, 3-36 [$\bar{x}$ = 18] µm long; basal appendage single, simple or branched, centric, 2-7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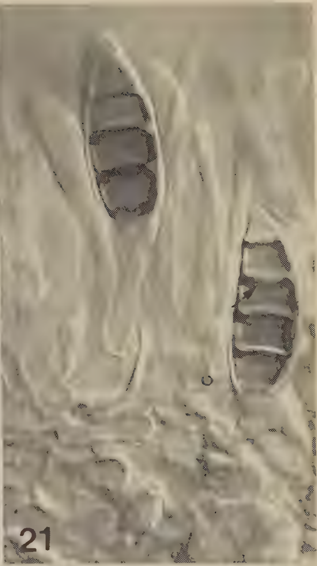
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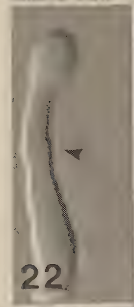
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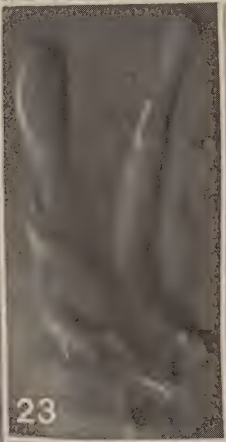
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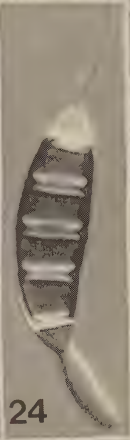
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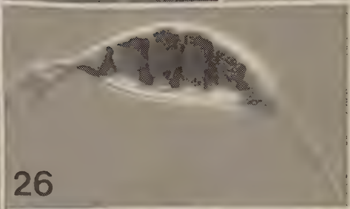
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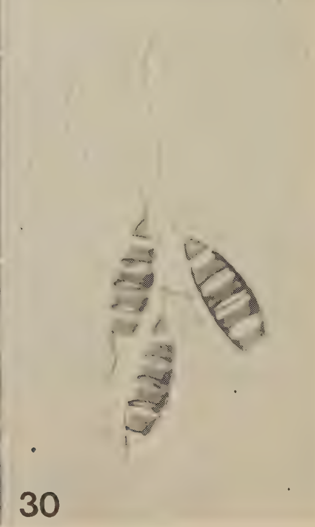
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Figs. 20-30. *Seiridium venetum* ex holotype in PAD. Fig. 20. v.s. of a conidioma; Fig. 21. Part of conidial hymenium; Figs. 22-24, 27. Conidiogenous cells with developing conidia; Figs. 25, 26, 29-30. Mature conidia; Fig. 28. Branched conidium appendage. (arrowheads in Figs. 22, 23 & 27 mark percurrent proliferations; arrows in Figs. 21 & 29 point to a septal pore); Fig. 20. X 165; Figs. 21, 24, 26-29, X 1100; Figs. 22 & 23, X 1760; Figs. 25 & 30, X 800.

[$\bar{x}$ = 4.5] µm long, occasionally absent; mean conidium length/width ratio = 3:1.

Habitat: On dead twigs of *Cornus alba, C. sanguinea, C. stolonifera*, and *Cornus* sp.

Specimens examined: 1. CFB - WINF (M) 6348, [slides ex HBG], on *C. alba*, München, Germany, X.1885, J.N.Schnabl; 2. CFB - WINF (M) 2333b, on *C.* sp., Seddon's corner, Man., Canada, 6.X.1965, B.C.Sutton, Jhant, J.J.Lawrence #299; 3. CFB - WINF (M) 4216, on *C.* sp., Dorothy Lake, Block 3, Whiteshell, Man., 8.VI.1966, B.C.Sutton, J.J.Lawrence #23; 4. CFB - WINF (M) 6744b, on *C.* sp., Montreal River Rd, nr. Molanosa, Sask., 23.V.1967, J.Beveridge #59; 5. CFB -WINF (M) 7249a, on *C.* sp., Forestry Rd., 1 mi. W of Hwy #10, Wasagaming, Man., Canada, 5.VII.1967, D.Shepherd #1191; 6. CFB - WINF (M) 7251a [collection data as in #5, D.Shepherd #1187]; 7. CFB - WINF (M) 8515, on *C.* sp., Candle lake, Sask., 28.VII.1967, B.C.Sutton #3618; 8. CFB - WINF (M) 10309a, on *C.* sp., Darwin, Man., 10.IX.1968, B.C.Sutton #3395; 9. CFB - WINF (M) 10380 [collection data as in #8, B.C.Sutton #3399]; 10. CFB - WINF (M) 12000a, on *C. stolonifera*, Iron Springs, Loon Lake, Sask., 17.IX.1968, B.B.McLeod; 11. PAD, on *C. sanguinea*, Selva, Italy, IX.1873 [type of *Pestalotia veneta* Saccardo].

Known distribution: Canada, Germany, Italy.

Teleomorph: Unknown.

The septal pores in conidia are clearly visible (Figs. 21 & 29). I have not been able to examine the collections of the fungus from France and England mentioned by Guba (1961).

Acknowledgments

I thank the curators at CFB - WINF, PAD, and SIENA for the loan of the specimens in their keeping. I am grateful to Prof. Bryce Kendrick, Dept. of Biology, University of Waterloo, and Dr. Amy Rossman, Systematic Botany & Mycology Laboratory, U.S. Department of Agriculture, Beltsville, Md., U.S.A. for critical reviews of this manuscript. I would like to thank the Canada Council, Ottawa for the award of a Killam Research Fellowship during the tenure of which part of this study was completed. Financial support from the Natural Sciences and Engineering Research Council of Canada in the form of an operating research grant to Prof. Kendrick is acknowledged.

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SOME NEW SPECIES AND NEW RECORDS OF DISCOMYCETES IN CHINA. III.

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ABSTRACT Five taxa are described as new: *Acervus epispartius* forma *albus, Coprobia magnifica, Otidea daliensis, Trichophaea pallidibrunnea,* and *Xeromedulla quercicola*. Eleven new records for China and name changes for four previously recorded Chinese discomycetes are listed.

NEW TAXA

1. **Acervus epispartius** forma **albus** Korf & W.-y. Zhuang, **forma nov.**

Ab Acervo epispartio *f.* epispartio *apotheciis totis albis differens.*

Apothecia deeply cupulate at first, almost applanate at maturity, when fresh hymenium white, with the faintest tinge of yellow-green, up to 1.4 cm in diam, with a very short stipe, arising from a fuzzy, downwardly tapering, pure white rhizomorph which branches at times and gives rise to more than one apothecium, less than 2 cm long, excipulum thin, white, clearly woolly, margin acute. Ectal excipulum of textura angularis, 45-65 µm thick, covered with hyaline hyphae, hyphae 7.5-10 µm wide, with blunt apices. Medullary excipulum of textura intricata, hyphae hyaline, 7-11 µm wide. Subhymenium of dense textura intricata. Hymenium 82-90 µm thick. Asci J– in Melzer's Reagent, 8-spored, ca 85 x 5.0-5.5 µm. Ascospores ellipsoid with blunt ends, uniseriate, slightly thick-walled when young, nonguttulate, 6.0-6.5 x 3.5-4.0 µm. Paraphyses filiform, not exceeding asci, 2.0-2.5 µm wide. On bare soil and duff.

Holotype: on bare soil and duff along path of Endangered Plant Collections, Xishuangbanna Botanical Garden, Mongla County, Yunnan, R.

P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (310), 25. X. 1988, HMAS 57686, CUP-CH 2534 (isotype).

Notes: The asci and ascospores fit *Acervus epispartius* (Korf, 1963; Pfister, 1975; Pfister & Bessette, 1985), but the white hymenium, pure white exciple, and pure white rhizomorphs do not fit that species (or any other *Acervus*) well. We treat it as a new form of the species.

2. **Coprobia magnifica** W.-y. Zhuang & Korf, **sp. nov.** Fig. 1.

Ab speciebus aliis Coprobiae *apotheciis magnis (9-16 mm diam), ascosporis horizontaliter striatis, et prominentibus hyphalibus capoillaribus unicellularibus clavatis ad marginem apothecialem praesentibus differens.*

Apothecia discoid, substipitate, hymenium dirty orange when fresh, (4-)9-16 mm in diam, receptacle surface concolorous with hymenium, faintly woolly especially at margin. Ectal excipulum of textura angularis, not clearly distinguished from medullary excipulum, the outermost cells with thicker walls than the inner ones, cells nearly isodiametric, ca 18-45 µm in diam, walls hyaline to subhyaline; receptacle surface undulate to pustulate at flanks, covered with thin-walled hyphae at very base of apothecium. Hyphal protrusions present at margin, clavate, with a blunt apex, one-celled, 25-50 µm long, walls subhyaline, cell contents subhyaline to pale brown; towards the flanks hyphal protrusions elongating to become hairs, 110-220 µm or longer, 6-10 µm wide, septate, not rigid, hyaline to subhyaline (or with a pale brown tint), hair walls not obviously thickened, arising from the outermost cells of ectal excipulum. Medullary excipulum of textura angularis, cell walls thin and hyaline. Asci J– in Melzer's Reagent, 8-spored, ca 175-200 x 9.5-11.0 µm. Ascospores ellipsoid, uniseriate, nonguttulate, with 13-14 horizontal striations on surface in cotton blue lactic acid, becoming somewhat shrunken when striations fully developed, some with a de Bary bubble (rarely two), very thick-walled when young, 12.5-16.6 x 7.5-10.0 µm. Paraphyses capitate, up to 8 µm diam at apex and ca 3 µm diam below. On cow dung.

Holotype: on cow dung, Ganhaizi, Lijiang, Yunnan, alt. 3170-3270 m, R. P. Korf, L.-s. Wang, & W.-y. Zhuang (339), 2. XI. 1988, HMAS 57687, CUP-CH 2531 (isotype).

Notes: Unlike most species of *Coprobia*, the ascospores are horizontally striate when mounted in cotton blue lactic acid. In no case did we see longitudinal striations. The perispore could not be loosened. The apothecia of this fungus are very large compared with the other species of the genus (Rifai, 1968; Thind & Kaushal, 1979; Moravec, 1984, 1987).

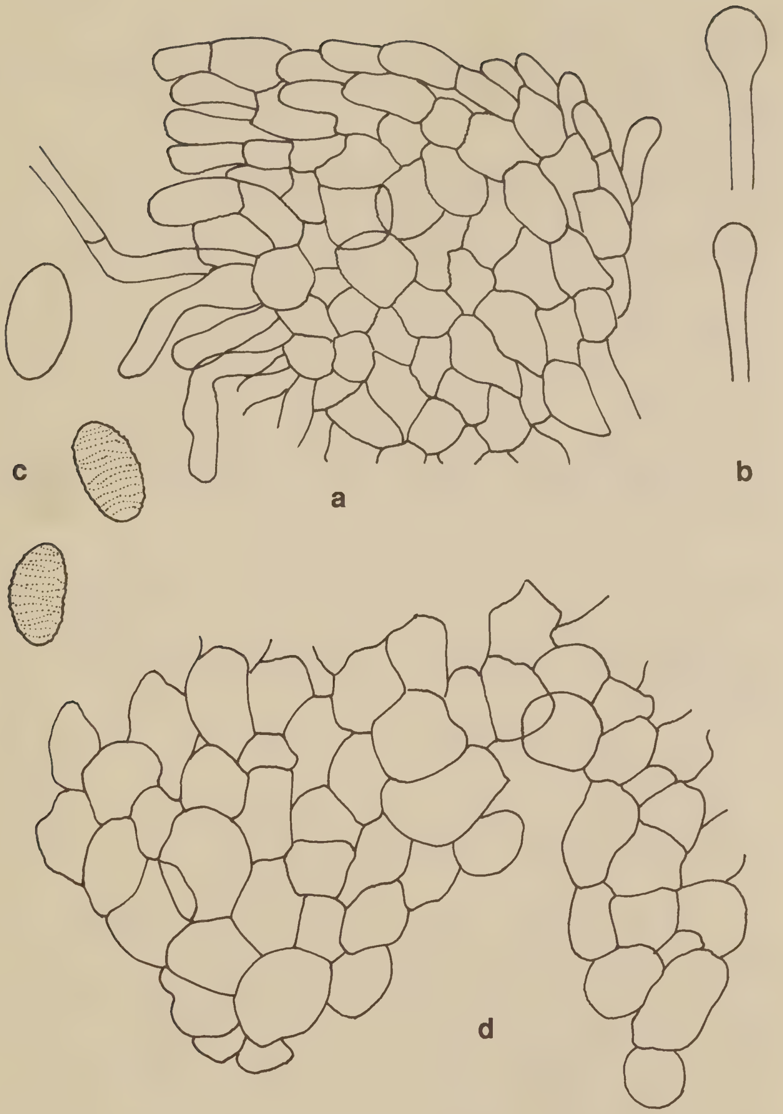

Fig. 1. *Coprobia magnifica:* **a**. ectal excipular structure at apothecial margin, **b**. two paraphysis apices, **c**. three ascospores, two with horizontal striations on surface, **d**. ectal excipular structure at flank; **a**, **d** x 412, **b**, **c** x 1030; from holotype.

3. **Otidea daliensis** W.-y. Zhuang & Korf, **sp. nov.** Fig. 2.

Ab speciebus aliis Otideae *characteribus consociatis apotheciorum parvorum (3-9 mm diam) discoideorum, ascosporis magnis (18-21* x *10-12 µm), et ascis magnis (172-205* x *15-17 µm) differens.*

Apothecia deeply cupulate, sometimes otideoid, pseudostipitate, 3-9 mm in diam, hymenium brown, in age dark brown, receptacle surface buff to light brown, margin somewhat darker, mealy to pustulate. Ectal excipulum of textura angularis, receptacle surface pustulate, ca. 50-85 µm thick excluding pustules; pustules of textura globulosa, ca 40-85 µm high, cells arranged in chains, isodiametric, loosely interconnected; ectal excipular cells ca 10-35 µm diam, walls yellow. Medullary excipulum of textura intricata, 150-255 µm thick, hyphae with pale brown contents, 3.0-3.5 µm wide, walls subhyaline. Hymenium ca 220 µm thick. Asci J– in Melzer's Reagent, 8-spored, ascus apices obviously lower than hymenium surface, 172-200 x 15-17 µm. Ascospores ellipsoid, mostly uniseriate, smooth-walled, biguttulate when young, 18-21 x 10-12 µm. Paraphyses strongly hooked at apex, multiseptate,often branched below, apical cells with yellow-brown cytoplasm, 3 µm wide. On bare soil.

Holotype: on bare soil under seedlings of *Plantago major* L., Hudiequan Park, Dali, Yunnan, alt. 2100 m, R. P. Korf, L.-s. Wang, & W.-y. Zhuang (395), 5. XI. 1988, HMAS 57688, CUP-CH 2532 (isotype).

Notes: This species, on microscopic characters surely an *Otidea,* is characterized by its unusually small apothecia and relatively large ascospores.

4. **Trichophaea pallidibrunnea** W.-y. Zhuang & Korf, **sp. nov.** Fig. 3.

Ab speciebus aliis Trichophaeae *pilis multum pallidioribus, cellulis excipularibus ectalibus pallidis, et ascis latis clavatis differens.*

Apothecia discoid to shallow cupulate, 2-4.5 mm in diam, sessile, hymenium light yellowish, buff to somewhat brown, margin thin and fringed. Ectal excipulum of textura angularis, ca 30-65 µm thick, cells hyaline to subhyaline, nearly isodiametric, 7-25(-45) µm in diam, axes of cells more or less perpendicular to outer surface, marginal cells in rows, at an angle to hymenium surface, ectal excipulum at margin much thicker than at flanks. Hairs pale brown, 4-12 or more in a fascicle, (0-)1-4 (or more) septa, tapering towards the apex, with round to pointed apex, relatively thick-walled, not as rigid as other species of *Trichophaea,* 50-230 µm long, short at margin and long at flanks, hyaline and flexuous at base, 4-8 µm at the widest part. Medullary excipulum of textura intricata, cells hyaline and thin-walled, at apothecial base not clearly distinguished

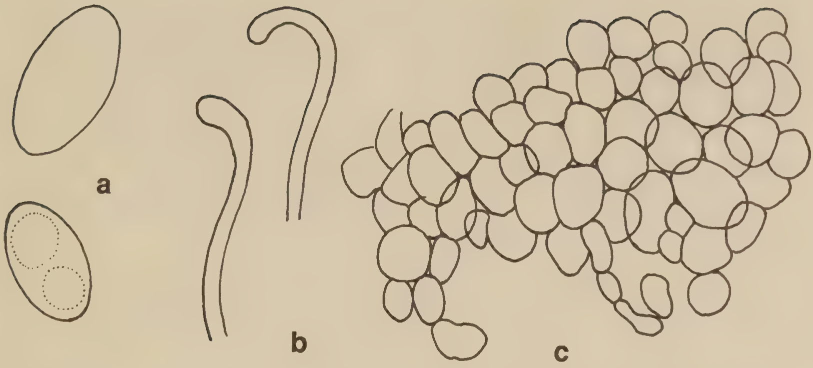

Fig. 2. *Otidea daliensis:* **a**. two ascospores, **b**. two paraphysis apices, **c**. structure of ectal excipulum; **a**, **b** x 1030, **c** x 412; from holotype.

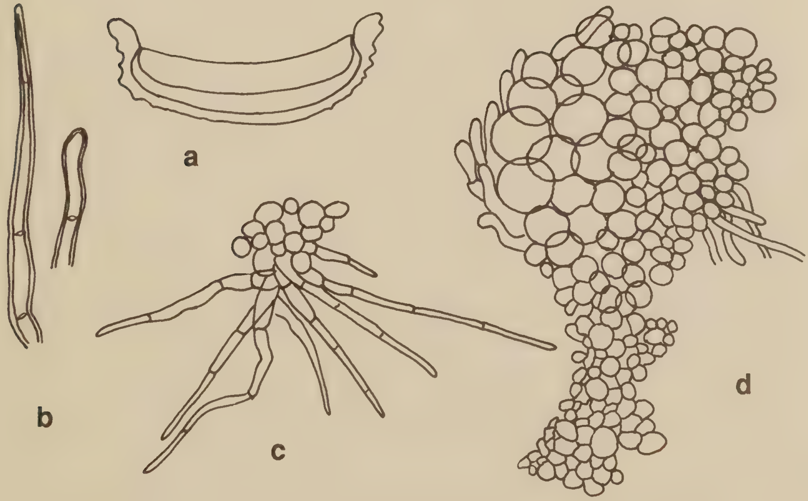

Fig. 3. *Trichophaea pallidibrunnea:* **a**. diagram of apothecium in section, from top to bottom showing hymenium, medullary excipulum, and ectal excipulum, **b**. two hairs, **c**. a fascicle of hairs, **d**. structure at apothecial margin and upper flank; **a** x 15, **b** x 412, **c**, **d** x 206; from holotype.

from ectal excipulum. Asci J– in Melzer's Reagent, subcylindrical when young and clavate at maturity, arising from crozier, 180-220 x 15-19 µm. Ascospores ellipsoid, smooth-walled, uniseriate to irregularly biseriate, uni- to biguttulate, 17.6-21.0 x 9.0-9.7 µm. Paraphyses filiform, 2.5-4.0 µm wide. On soil.

Holotype: on moist soil, Tanzhesi, Beijing, R. P. Korf & W.-y. Zhuang (184), 8. X. 1988, HMAS 57689.

Other specimen examined: on soil among small mosses around two-needle pine in temple ground, Tanzhesi, Beijing, R. P. Korf & W.-y. Zhuang (185), 8. X. 1988, HMAS 57690.

Notes: The apothecial color was too light for this to be recognized as a *Trichophaea* in the field. Under the microscope the hair color is the lightest known to us among species of this genus.

5. **Xeromedulla quercicola** Korf & W.-y. Zhuang, **sp. nov.** Fig. 4.

Ab X. tomentulosa *ascosporis lacrimiformibus, cellulis excipularibus lateralibus angulariubus vel laterculiformibus atque parietibus minus crassis praeditis, et pilis brevibus differens.*

Apothecia rather regularly spaced on lower surface of leaf, discoid, 0.4-0.5 mm in diam when rehydrated, short-stipitate, triangular or laterally appressed in shape when dry, faintly hairy on the receptacle surface, lemon-yellow when dry, ivory to semitranslucent when rehydrated. Ectal excipulum of textura oblita at margin and at flanks near margin, of textura angularis to textura globulosa at base and at flanks near base, ca 20-25 µm thick, cells isodiametric to brick-shaped, hyaline, glassy- and thick-walled, receptacle surface covered with a thin layer of gel especially at margin, tissues gelatinized at margin and upper flanks, hyphal ends protruding through gel and from the outermost cells of ectal excipulum. Hyphal protrusions banana-shaped at margin, curved to slightly undulate at flanks, 0-1-septate, more or less equal in width, 5-17 x 2.5-3.0 µm, surface granulate. Medullary excipulum of textura intricata, very thin and almost absent near margin, 3-15 µm thick at flanks, hyphae hyaline, thin-walled. Asci clavate, J+, pore walls with two blue dots in Melzer's Reagent, 8-spored, ca 30 x 3 µm. Ascospores teardrop-shaped, uniseriate, unicellular, 3-4 x 1 µm. Paraphyses filiform, slightly enlarged at apex, apices sometimes encrusted by amorphous substances, slightly longer than asci.

Holotype: on a fallen leaf of *Quercus*, Tanzhesi, Beijing, alt. 350 m, B.-c. Zhang (525), 16. X. 1988, HMAS 57691, CUP-CH 2535 (isotype).

Notes: The ectal excipulum of this species at margin and at flanks near the margin is of textura oblita and thus differs from that of the other two species in the genus (Zhuang & Korf, 1987). *Xeromedulla leptospora* and *X. tomentulosa* were reported from the Philippines while *X.*

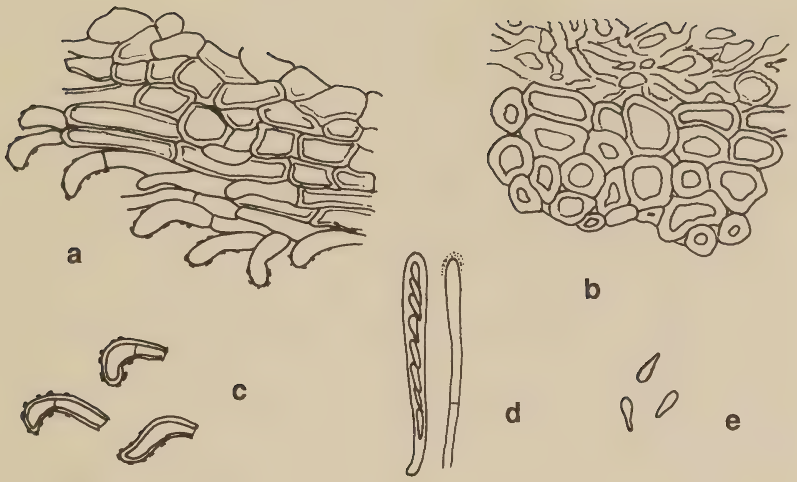

Fig. 4. *Xeromedulla quercicola:* **a**. ectal excipulum at flank near margin, **b**. ectal excipulum at flank near base, **c**. three hairs, **d**. an ascus and a paraphysis apex, **e**. three ascospores; all x 1030; from holotype.

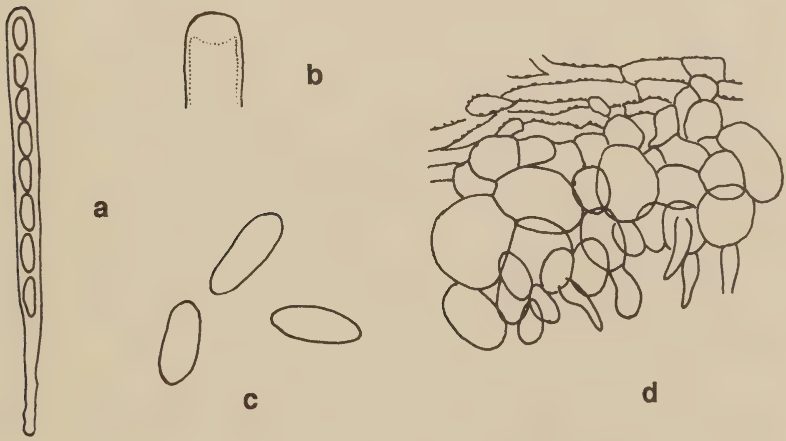

Fig. 5. *Moellerodiscus* sp.: **a**. an ascus, **b**. an ascus apex, **c**. three ascospores, **d**. excipular structure; **a**, **d** x 412, **b**, **c** x 1030; from HMAS 57694.

quercicola occurs in the temperate zone.

NEW RECORDS FOR CHINA

6. **Cordierites sprucei** Berk.

Diagnostic features: Apothecia discoid to infundibuliform, eccentrically stipitate, stipes arising from a common base or more or less branched, hymenium with a red-brown cast and receptacle black when fresh, hymenium dark purple brown, outside purplish black, receptacle surface slightly roughened, up to 8 mm in diam when dry. Tissues exuding dark purple pigmentation in aqueous KOH solution (ionomidotic reaction). Ectal excipulum of textura angularis to textura prismatica, receptacle covered with short hyphal protrusions. Medullary excipulum of textura intricata, hyphae parallel. Asci J– in Melzer's Reagent, subcylindrical. Ascospores ellipsoid, ca 4 x 2.2 µm.

Specimen examined: on rotting hard wood, in forest of *Quercus, Acer, Tilia,* and *Pinus,* Dayangcha, Baihe, Jilin, R. H. Petersen (1419), 7. VIII. 1988, HMAS 56494.

Notes: HMAS 56494 was collected in Jilin Province. The occurrence of this species is thus now known from South America, Africa, the Philippines, Northeast China, and the Soviet Union (Zhuang, 1988).

7. **Encoelia helvola** (Jungh.) Overeem

Diagnostic features: Apothecia discoid, gregarious, tough, often irregularly enrolled, up to 8 mm in diam, hymenium orange-tan, receptacle light tan, strongly pustulate, short-stipitate, stipes concolorous with receptacle or darker. Ectal excipulum of textura globulosa to textura angularis, receptacle surface strongly pustulate, ca 45-50 µm thick (excluding the pustules), cells isodiametric, hyaline, thick- and glassy-walled, pustules ca 40-80 µm high. Medullary excipulum of textura intricata, 230-250 µm thick at flanks, hyphae glassy- and relatively thick-walled. Hymenium ca 70 µm thick. Asci J– in Melzer's Reagent, ca 60-65 x 5-6 µm. Ascospores elongate ellipsoid, some faintly bent, uni- to biseriate, hyaline, biguttulate when young, nonguttulate at maturity, 6-8 x 2.0-2.5 µm. Paraphyses filiform, not enlarged at apex, ca 9 µm longer than ascus apices.

Specimen examined: on cankers at internodes of living bamboo plants, along path of the Endangered Plant Collections, Xishuangbanna Botanical Garden, Yunnan, R. P. Korf, M. Zang, K.-k. Chen, & W.-y. Zhuang (311), 25. X. 1988, HMAS 54037.

Notes: The morphology of the Chinese collection fits well the description and illustration provided by C. van Overeem (1926).

8. Hymenoscyphus cfr. **caudatus** (Karst.) Dennis, sensu Dumont & Carpenter Fig. 6a.

Diagnostic features: Apothecia discoid, short-stipitate, up to 1.8 mm in diam when dry, hymenium orange-yellow. Ectal excipulum of textura angularis, with a covering layer of elongate hyphae. Medullary excipulum of textura intricata. Hymenium ca 140 µm thick. Asci 8-spored, 10.5-11.5 µm wide, with a thick apex and a long apical pore, pore walls blue in Melzer's Reagent. Ascospores elongate-fusoid, often biseriate, multiguttulate, 23-27 x 4.5-5.5 µm. Paraphyses cylindrical, not exceeding asci.

Specimen examined: on roots of a grass, Tanzhesi, Beijing, R. P. Korf & W.-y. Zhuang (465), 8. X. 1988, HMAS 57692.

Notes: HMAS 57692 differs from the typical *Hymenoscyphus caudatus* in the larger apothecia, larger ascospores, and occurrence on roots of a grass instead of on leaves of dicotyledons. The description of the fungus given by Dumont and Carpenter (1982) records larger ascospores than that by Dennis (1978).

9. Ionomidotis frondosa (Kobayasi) Kob. & Korf

Diagnostic features: Apothecia ear-shaped, lobed, individuals ca 13 mm wide and 13 mm high when dry, several arising from a common base, hymenium black and receptacle surface wrinkled when dry, outside minutely pustulate, tissues ionomidotic. Ectal excipulum of textura angularis, ca 35-40(-50) µm thick, cells in gel, nearly isodiametric, cells darker in pustules than in inner layers. Medullary excipulum of textura intricata, ca 140 µm thick, tissues brownish. Subhymenium 38-43 µm thick, darker than medullary excipulum. Hymenium 43-45(-50) µm thick. Asci J– in Melzer's Reagent, ca 30-35 x 3.5-4.5 µm. Ascospores rod-shaped to allantoid, with 2-3 guttules, 4.5-5.5 x 1.1-1.4 µm. Paraphyses curved, straight, or circinate at apex, slightly enlarged at apex, up to 1.8 µm at the widest part.

Specimen examined: on wood, west of Sichuan, Z.-y. Yang, autumn of 1984, HMAS 57693.

Notes: This fungus has been reported as *Mollisia* sp., with a detailed description and illustration (Mao, 1987). The local people and the collector indicated that it is a poisonous "mushroom."

10. Moellerodiscus sp. (nov.) Fig. 5.

Apothecia on a very thin layer of black stroma, discoid, 1-3.5 mm in diam, stipe approximately equal to diam of disc, margin even, hymenium pinkish beige, receptacle slightly darker, stipe much darker at base, receptacle surface furfuraceous. Ectal excipulum of textura angularis to textura globulosa, ca 3-4 cell layers, 50-75 µm thick, cells subspherical to ovoid, walls hyaline, outermost cells giving rise to pointed to blunt very short protrusions which stain in cotton blue, 10-22 x 3.8-7.5 µm. Medullary excipulum of textura intricata, hyphae at flanks more or less parallel to outer surface, walls hyaline to subhyaline, mostly smooth but clearly marked in hyphae adjacent to the ectal excipulum. Subhymenium of textura intricata, hyphae subhyaline to slightly pigmented, ca 25-50 µm thick. Hymenium ca 170 µm thick. Asci subcylindrical, 8-spored, occasionally with only 4 spores mature (spores in 4-spored asci larger than normal), J+ in Melzer's Reagent (pore walls blue with two basal dots dark), 150-160 x 8-9 µm. Ascospores ellipsoid, uniseriate, biguttulate to multiguttulate when young, nonguttulate at maturity, 10-13(-14) x 4.5-5.3 µm. Paraphyses filiform, 2 µm wide, not exceeding asci.

In culture colony white, with some aerial hyphae at beginning, later producing many small, black, thin-layered stromata, stromata spherical, ellipsoid, or elongate to irregular in shape, centrally elevated, 2-5 mm in diam if spherical, or 2.5-6.5 x 3.5-12 mm, long stalk-like structures bearing a tiny, immature apothecium arising from the black stroma.

Specimen examined: on black, thin stroma along midrib of a skeletonized leaf of *Salix* sp. Heilongtan, Miyun County, Beijing, R. P. Korf & W.-y. Zhuang (468), 10. X. 1988, HMAS 57694.

Notes: This is a new taxon of *Moellerodiscus*. Since the collection is too poor to be a type, we record the fungus under *Moellerodiscus* sp. and await more ample collections.

11. **Orbilia curvatispora** Boud. Fig. 7.

Diagnostic features: Apothecia flat but centrally depressed, dirty orange when dry, convex when rehydrated, sessile with central attachment, 0.3-0.7 mm in diam, hymenium and receptacle smooth. Ectal excipulum of textura angularis, 35-43 µm thick. Medullary excipulum of textura intricata, 23-32 µm thick. Hymenium ca 36 µm thick. Asci J– in Melzer's Reagent, 30-43 x 3.0-3.5 µm. Ascospores elongate, curved or straight, one end sometimes faintly narrow, 9-13 x 0.7 µm. Paraphyses with a knob at apex.

Specimen examined: on a piece of bark, Sanming, Fujian, H.-z. Li, 18.VII. 1974, HMAS 57695.

Notes: We did not observe the obvious anchoring hyphae at the base of apothecia, which has been reported by some authors.

12. **Peziza** cfr. **saccardiana** Cooke Fig. 6b.

Diagnostic features: Apothecia cupulate to discoid, sessile, up to 20

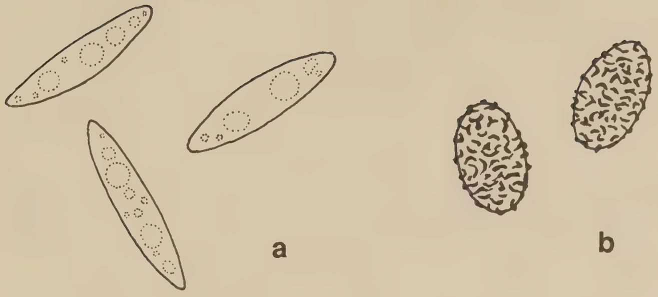

Fig. 6. Ascospores of two discomycetes: **a**. *Hymenoscyphus* cfr. *caudatus,* **b**. *Peziza* cfr.*saccardiana;* all x 1030; **a** from HMAS 57692, **b** from HMAS 57696.

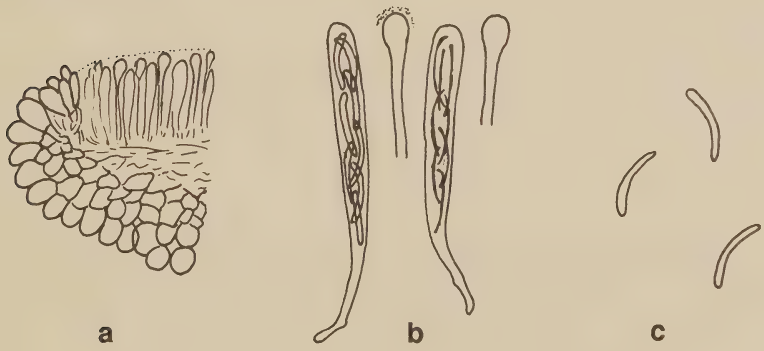

Fig. 7. *Orbilia curvatispora:* **a**. diagram of excipular structure at and near margin, **b**. asci and paraphysis apices, **c**. three ascospores; **a** x 350, **b**, **c** x 1030; from HMAS 57695.

mm in diam, hymenium and receptacle brown to dark brown. Ectal excipulum of textura angularis; medullary excipulum of textura angularis, with a few wide hyphoid cells, cells becoming smaller towards hymenium; subhymenium of dense textura angularis. Hymenium ca 235 µm thick. Asci J+ in Melzer's Reagent, 10-15 µm wide. Ascospores ellipsoid, uniguttulate to biguttulate, 15-17 x 8-9.5 µm (excluding markings), with markings on surface, warts spherical (0.5 µm in diam), or irregularly elongate to curved, 0.5-0.8 µm high.

Specimen examined: on soil under a two-needle pine, Tanzhesi, Beijing, R. P. Korf & W.-y. Zhuang (183), 8. X. 1988, HMAS 57696.

Notes: The size, guttulation, and marking shape of the ascospores of this fungus are similar to those of *Peziza saccardiana*.

13. **Scutellinia kerguelensis** (Berk. in Hook.) Kuntze

Diagnostic features: Apothecia discoid, sessile, (3-)4-6(-8) mm in diam when dry, hymenium light orange when fresh, margin with brown setae. Hairs brown, with 1(-3) rootlet(s), 153-330(-520) µm long, (15-)18-28(-38) µm wide. Ascospores ellipsoid, multiguttulate, 19-24 x 10.5-14.5 µm, with markings on surface, some markings interconnected; young spores thick-walled and with a non-stained, fine, longitudinal belt on one side when mounted in cotton blue lactic acid. Paraphyses enlarged to 6-9 µm wide at apex.

Specimen examined: on a trunk covered with a thin layer of sandy soil, Motuo, Xizang, alt. 3300 m, J.-y. Zhuang (XZ 28), 19. VIII. 1983, HMAS 57697.

Notes: According to Schumacher (1987) this species occurs in cool climates and high altitude. The Chinese collection (HMAS 57697) was found at the altitude of 3300 m in Motuo, Xizang (Tibet).

14. **Smardaea** cfr. **protea** Zhuang & Korf

Diagnostic features: apothecia discoid, substipitate to sessile, 3-6 mm in diam when fresh, hymenium dark purple, receptacle concolorous. Ectal excipulum of textura angularis to textura globulosa, ca 50 µm thick, cells isodiametric, 11.5-23 µm in diam. Medullary excipulum of textura intricata, 250-350 µm thick at flanks. Hymenium ca 360 µm thick. Asci J– in Melzer's Reagent, 15-18 µm wide. Ascospores long-ellipsoid, mostly biguttulate, 20-24 x 10.0-10.5 µm, with irregular warts on surface, markings angular, varying in size. Paraphyses filiform, 4-5 µm wide.

Specimen examined: on duff on moist soil, Songshan Natural Preserve, Beijing, X.-d. Zhu & W.-y. Zhuang (166), 13. IX. 1988, HMAS 57698.

Notes: Most apothecia of this collection are not fully mature.

Although the spore markings are loosely attached to the spore surface and the medullary excipulum is thicker, the general morphology of the Chinese fungus is very similar to the original description of *Smardaea protea* (Zhuang & Korf, 1986), known from Czechoslovakia.

15. **Tricharina gilva** (Boud. in Cooke) Eckblad

Diagnostic features: Apothecia discoid, sessile, 2-5 mm in diam when fresh, hymenium yellowish orange, receptacle lighter and covered with hyaline hairs. Hairs hyaline, with pointed apex and 3-4 septa, 126-200 x 9-14 µm. Ectal excipulum of textura angularis, cells up to 90 µm in diam. Asci J– in Melzer's Reagent, ca 153-165 x 11.5-12.5 µm. Ascospores ellipsoid with truncate ends, contents refractive, nonguttulate, 13.5-18.0 x 8.0-10.2 µm. Paraphyses slightly enlarged or not at apex, 3-5 µm wide at apex and 3-3.5 µm wide below.

Specimens examined: on soil in a flower pot, Zhongguancun, Beijing, J.-z. Zhou, early March, 1988, HMAS 57699; on soil, Zhongguancun, Beijing, X.-q. Zhang & S.-y. Ren, 4. X. 1988, HMAS 57700.

16. **Trichophaea gregaria** (Rehm) Boud. forma **gregaria**

Diagnostic features: Apothecia cupulate to hemispherical, rarely discoid, up to 5 mm in diam, hymenium pale buff to rosy buff, receptacle covered with brown hairs. Ectal excipulum of textura angularis, ca 75-80 µm thick at flanks; hairs arising from the outermost cells of ectal excipulum, very dense at margin and in fascicles at flanks. Setae brown, thick-walled, 2-6 septa, ca 82-306 µm long, very short at apothecial base. Medullary excipulum of textura intricata to textura angularis. Hymenium ca 255 µm thick. Asci usually 8-spored, 11-14(-17) µm wide. Ascospores ellipsoid, uniguttulate, mostly (17.5-)19.2-22.0 x 10-12 µm, some gigantic spores 23-28 x 15-16.5 µm; surface with minute warts, 0.2-0.4 µm in diam. Paraphyses slightly enlarged at apex.

Specimens examined: on mossy soil, Stone Forest, Lunan, Yunnan, R. P. Korf, K.-k. Chen, & W.-y. Zhuang, 19. X. 1988, HMAS 57709; on soil in forest around Huatingsi, Kunming, Yunnan, R. P. Korf, Z.-l. Yang, P.-g. Liu, & W.-y. Zhuang (432, 433), 9. XI. 1988, HMAS 57701, 57706.

PREVIOUSLY REPORTED SPECIES FOR WHICH DIFFERENT NAMES ARE REQUIRED

17. **Ascocoryne cylichnium** (Tul.) Korf

This species was previously recorded in China as *Coryne urnalis* (Nyl.) Sacc. (Tai, 1979). Korf (1971) listed the name as a synonym of

Ascocoryne cylichnium. The morphology of HMAS 57702 is very similar to the fungus Christiansen (1962) described as "*Coryne cylichnium* (Tul.) Boud. var. nov. on moss-grown stump," but neither a Latin diagnosis nor a varietal name was provided. The ascospores of the Chinese collection measured 23-28 x 4-5 µm.

Specimen examined: on wood covered with mosses in Nanjinghexi, Fujian, H.-z. Li (FJ 331), 5. VI. 1976, HMAS 57702.

18. Calycina herbarum (Pers. : Fr.) Gray

This is for the previously recorded *Helotium herbarum* (Pers.) Fr. (Tai, 1979). We agree with Baral and Krieglsteiner (1985) that a genus *Calycina,* based on this species, should be recognized in the Hyaloscyphaceae. In culture of our recent collection (HMAS 57703), we observed a *Phialophora*-like fungus which produced white, horn-like synnemata, light brown conidiogenous cells, and hyaline phialidic endoconidia. Further study is needed to confirm the connection between the conidial fungus and *Calycina herbarum.*

Specimen examined: on herbaceous stems, Heilongtan, Miyun County, Beijing, R. P. Korf & W.-y. Zhuang (471), 10. X. 1988, HMAS 57703.

19. Microstoma cfr. **floccosum** (Schw.) Rait.

The Chinese collection (HMAS 57704) is similar to *Microstoma floccosum,* but with larger ascospores than the typical material and smaller spores than the Japanese variety, *M. floccosum* var. *macrosporum* Otani. The junior author doubts whether this is *M. floccosum,* a species well known in North America. A detailed comparison between Asian materials and North American ones is needed to reach a final conclusion.

Specimen examined: on twigs, Milin, Xizang, alt. 3580 m, J.-y. Zhuang (XZ16), 24. VI. 1983, HMAS 57704.

20. Trichophaea abundans (Karst.) Boud.

"*Scutellinia abundans* Kuntze" has been recorded in China (Tai, 1979). This species was recently collected by us on burnt palm materials. But the correct generic name for the fungus should be *Trichophaea,* and Karsten is the author of the epithet. The anamorph, *Dichobotrys abundans* Hennebert, was produced easily on PDA medium and apothecia were found in the same culture 25 days after inoculation.

Specimen examined: on burnt palm materials, Xishuangbanna Botanical Garden, Yunnan, R. P. Korf, M. Zang, K.-k. Chen, & W.-y.

Zhuang (196), 21. X. 1988, HMAS 57705.

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ASCORHIZOCTONIA ASCOPHANOIDES SP. NOV.: ANAMORPH OF *TRICHARINA ASCOPHANOIDES*

CHIN S. YANG[1] and ROY KRISTIANSEN[2]

Tricharina ascophanoides (Boud.) Yang & Korf is a rare discomycete, and only a few specimens have been collected, preserved, and identified (Yang and Korf, 1985 b) since Boudier (1903) first described the species. Recently, three large collections were made in southern Norway by RK and positively identified by CSY with Yang and Korf's key (Yang and Korf, 1985 b) on the basis of their relatively thin-walled, hyaline to subhyaline marginal hairs in clusters, ellipsoid uniseriate to occasionally sub-biseriate ascospores, and obvious fine polar granules in the ascospores. The three collections were solitary or gregarious, growing on wet and/or burnt paperballs in a rubbish dump. These are deposited in TRH. This is the first record of *T. ascophanoides* in Fennoscandia.

During the monographic study of the genus *Tricharina* Eckblad, several species of the genus were cultured on agar medium and anamorphs were described (Yang and Korf, 1985 a). *Tricharina ascophanoides* was not one of the species yielding an anamorph at that time, because only a few old specimens were available. RK's collections were revived and ascospores were germinated following the procedures of Yang and Korf (1985 a). Here we report on our studies and descriptions of an isolate, designated as CSY 123, from the collection RK 82.146.

Spore germination of *T. ascophanoides* is similar to or identical to that of other species of *Tricharina* described by Yang and Korf (1985 a). Hyphal extensions from the apothecial pieces are visible to the naked eye 2-3 days following treatment. The initial germ tube emerges terminally or subterminally from one end of the ellipsoid ascospores. Most spores later develop another germ tube from the other end of the spore. The emerging germ tubes are fast growing, at first straight, rarely branched or fused with other nearby germ tubes.

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Growing hyphae from the germinating ascospores quickly form a culture when transferred to nutrient media. The culture is medium to fast growing (Table 1) and *Ascorhizoctonia*-like. A growth rate study identical to that conducted by Yang and Korf (1985 a) was performed, and the results are presented in Table 1. Four growth media, WA (1.2% water agar), MEA (2% malt extract agar), PDA (potato dextrose agar), and CMA (cornmeal agar), were used. All inoculated plates were incubated in the dark at room temperature (approximately 20-25 C). Growth rates were measured on the fourth day after the inoculation.

Table 1. Mycelial growth of *Ascorhizoctonia* anamorph of *T. ascophanoides* on four nutrient media as measured in radial diameter four days after inoculation.

	WA	CMA	MEA	PDA
CSY 123 ex RK 82.146	4.1-4.7X4.0-4.6 *	4.0-4.6X4.0-4.8	3.8-4.2X3.9-4.2	4.1-4.6X4.2-4.6

*Radial diameter in centimeters (range includes four plates).

The culture was not as fast growing as other species of *Ascorhizoctonia* under the same conditions (Yang and Korf, 1985 a) and only on CMA did it produce obvious concentric bands in 4 days. The culture covered the 90 mm plates in 10-14 days. The culture produced chlamydospore-like aggregates on all media but they were much more abundant on MEA and PDA. The chlamydospore-like aggregates were in concentric bands on MEA and PDA, formed in the first 2-4 weeks, and might or might not merge together later on and become brownish to brown. The aggregates which formed on WA and CMA 2-3 weeks after inoculation were whitish initially and became brownish in or on the agar.

Because the anamorph of *Tricharina ascophanoides* has never been obtained and described before, we describe here the culture CSY 123 (ex RK 82.146) as a new species in the genus *Ascorhizoctonia.*

Ascorhizoctonia ascophanoides Yang *et* Kristiansen, sp. nov. Fig. 1. *Cultura generaliter valde similis culturae A. ochroleuca est, sed different zonis concentricis in CMA et MEA. A. ascophanoides (Tab. 1) leniter quam A. ochroleuca crescens* (Tab. 3, Yang & Korf, 1985 a). *Holotypus*: *Norvegia*, R. Kristiansen, TRH (ex RK 82.146, CSY 123) *Teleomorphosis: Tricharina ascophanoides* (Boud.) Yang & Korf.

Mycelium covering 90 mm plates of water agar, malt extract agar, potato extract agar, and cornmeal agar in 2 weeks, no concentric bands formed on

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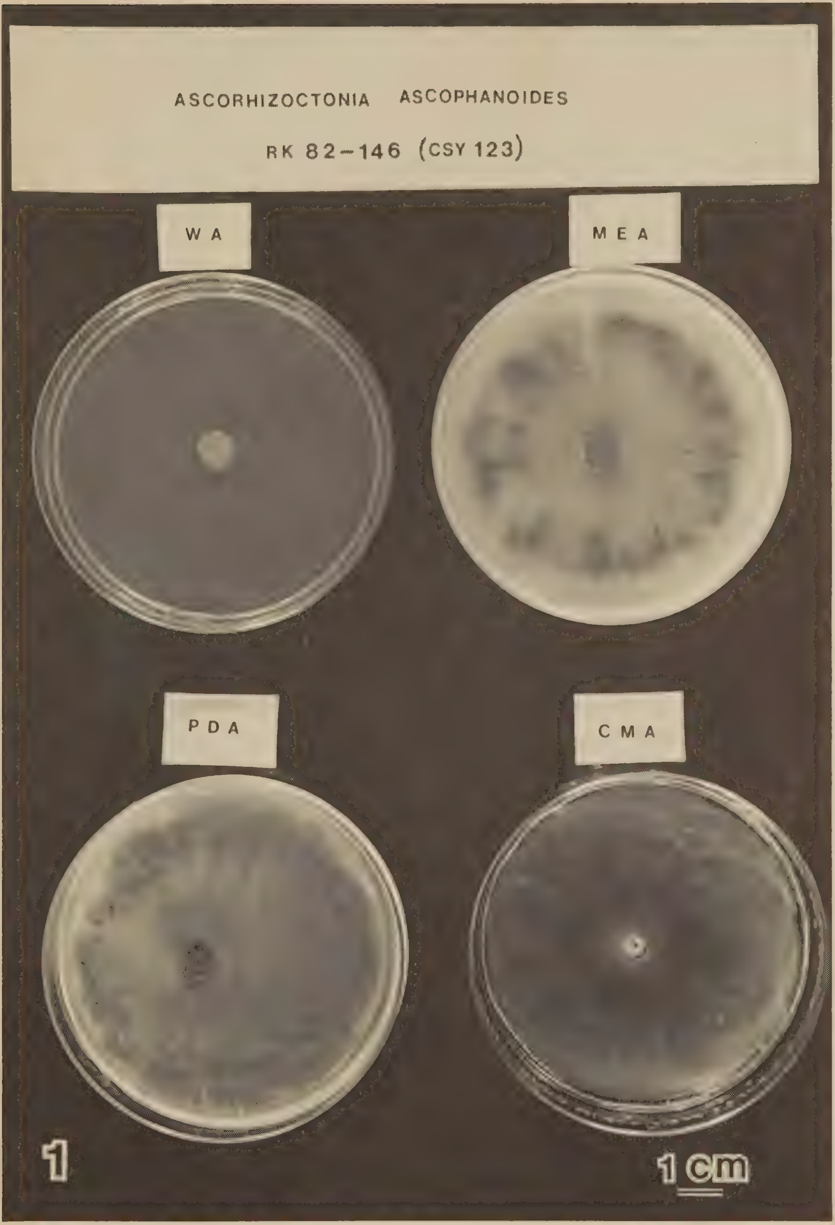
Fig. 1. Colony morphology of Ascorhizoctonia ascophanoides on WA, CMA, MEA, and PDA. Scale = 1 cm.


ASCORHIZOCTONIA ASCOPHANOIDES
RK 82-146 (CSY 123)
W A
M E A
P D A
C M A
1 cm

1

WA, 1-2 bands formed on CMA, 3-5 bands on PDA or MEA. Concentric bands formed by chlamydospore-like aggregates present on aged PDA that may fuse together (Fig. 1), similar to those of *A. ochroleuca* Yang & Korf. Mycelium hyaline to yellowish on WA to grayish brown on PDA, mostly appressed and immersed with visible aerial hyphae, and producing chlamydospore-like (monilioid cell) aggregates in all media, fewer on WA. Hyphae cylindrical, simple septate, hyaline to pale brown, smooth, 2.0-10.0 µm broad, with right to almost right angle branching, containing oil globules usually smaller than 5.0 µm in diam; delimiting septum 3-5 µm into the branch or at or near the junction. Monilioid cells subhyaline to brownish, limoniform or subglobose, 16.2-32.0 µm broad, containing oil drops mostly 4.0-11.2 µm in diam, some as large as 15.0 µm .

Holotype: Dried culture derived from a specimen (RK 82.146) collected by R. Kristiansen in Norway in 1982, TRH. Isotypes in CUP, K, PRM, and S. Living cultures maintained at ATCC, CBS, DAOM, and IMI.

CSY 123 is in general very similar to that of *A. ochroleuca*, however it has concentric bands on CMA and MEA. The growth rate of *A. ascophanoides* (Table 1) was slower than that of *A. ochroleuca* (Table 3; Yang and Korf, 1985 a).
Holotype: Dried culture derived from an isolate (CSY 123) from specimens collected at TORP, just north of Fredrikstad, Norway, 3. VII. 1982 by R. Kristiansen, ex RK 82.146, deposited in TRH.

Mode of spore germination, growth pattern and morphology of the culture, and teleomorph connection suggest that the culture belongs to *Ascorhizoctonia.* This also reaffirms the placement of the teleomorph in the genus *Tricharina* and the segregation of *Tricharina* and *Wilcoxina* .

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STUDIES IN THE HYALOSCYPHACEAE V: SPECIES DESCRIBED BY C. H. PECK[1]

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ABSTRACT

Seventeen species of Hyaloscyphaceae (Order Leotiales) originally described by C. H. Peck are reevaluated or redescribed. The following new combinations are proposed: *Trichopeziza albotestacea* var. *agrostina* (Pk.) Haines [=*Peziza agrostina*, =*Albotricha longispora* Raitv.], *Cistellina chamaeleontina* (Pk.) Haines, *Perrotia distincta* (Pk.) Haines [=*Perrotia phragmiticola* (P. Henn. & Ploettn.) Dennis], *Lachnum luteodiscum* (Pk.) Haines [=*Lachnum albidoroseum* (Rehm) Nannf.], *Lachnum clavisporum* (Mout.) Haines, *Lachnum myricaceum* (Pk.) Haines, *Dasyscyphella sulphuricolor* (Pk.) Haines [=*Dasyscyphella cinnamomea* Raitv.] and *Amicodisca viridicoma* (Pk.) Haines. Descriptions and illustrations of *Solenopezia solenia* (Pk.) Sacc., *Lachnum sulphurellum* (Pk.) Raitv. [=*Lachnum cruciferum* (Phill.) Nannf.] and *Cistella grevillei* (Berk.) Massee [=*Peziza urticina* Pk.] are included as are notes on *Trichopeziza kalmiae* (Pk.) Sacc., *Trichopeziza leucophaea* (Pers.) Rehm [=*Lachnella bicolor* Pk.], *Lachnum capitatum* (Pk. in Thümen) Svrcek, *Trichopeziza relicina* (Fr.) Raitv. [=*Peziza longipila* Pk.], *Calycella subochracea* (Cke. & Pk.) Dennis and *Lachnella tiliae* (Pk.) Donk in Sing.

Early in his mycological career Charles Peck, best known for his work on fleshy fungi, described 17 species of discomycetes which are now, or have in the past been, included in the family Hyaloscyphaceae. Most of these have not been reevaluated in recent studies despite the fact that some of them should be in current usage. At the time of Peck's first publications, the fungi now treated in the

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Hyaloscyphaceae were all contained in one tribe of the genus Peziza. At the time of this writing the number of genera described in that family easily exceeds 100. The types of all seventeen of Peck's species have been reexamined are redescribed or discussed in the present work, and placed in the appropriate modern genera where appropriate.

Trichopeziza albotestacea (Desm.) Sacc. var. agrostina (Peck) Haines **stat. & comb. nov.** Figs. 1,2.
Basionym: Peziza agrostina Peck, Annual Rep. New York State Mus. 29: 55. 1878.
=Trichopeziza agrostina (Peck) Sacc., Syll. Fung. 8: 421. 1889.
=Lachnella agrostina (Peck) Seaver, North Amer. Cup-Fungi, p. 259. 1951.
=Albotricha longispora Raitv., Folia Crypt. Estonica 2: 14. 1973.

Apothecia up to 1.5 mm in diam. when fully expanded, scattered to crowded on grass culms, sometimes in great swarms on the substrate, goblet-shaped with disc concealed by hairs when immature or dry, salviform with white to light yellow disc fully exposed and flat when mature and moist, short stipitate, pink-buff becoming buff-yellow with age. **Ectal excipulum** of moderately thick-walled, hyaline to brown pigmented, nearly cuboid-celled, textura prismatica only 1-2 cells in thickness, cells 5-8 µm across, somtimes inflated to approach textura globulosa in the upper portions. **Medullary excipulum** of densely packed, thin-walled, hyaline, textura intricata composed of hyphae ca. 2-3 µm in diam. **Hairs** up to 180 µm long by 3.0-5.0 µm at the widest point about 1/3 up from the base, tapered to 2.5-3.0 µm at the base and 1.0-2.0 µm at the hemispherical apex, septate forming cells 10-20 µm long, roughened by adhering granules which dissolve in 3% KOH, then appearing completely smooth, or sometimes with small granulations remaining, without resin deposits at the apex, faintly yellow-pigmented, thick-walled, walls up to 1 µm, lumen often about 1/3 of hair width, there appears to be an inner wall thickening by deposit of hyaline matter, flexible, bending readily in mounted material. Some hairs have a minutely pitted surface. Marginal hairs short and clavate, thin-walled, smooth and hyaline. **Asci** (45-)45-55(-64) X 3.5.0-5.5 µm, cylindrical with slightly tapered base lacking croziers, and hemispherical apex with distinct J+ pore, 8-spored. **Spores** (7.0-)9-16(-18.5) X 1.3-2.0 µm (ave. of 35= 11.9 X 1.7 µm) non-septate. **Paraphyses** lanceolate 3.8-5.2 µm at their widest point, with acute apices when mature, superceeding the asci by up to 20 µm.

Type: U.S.A., Albany Co., West Albany, New York, on dead stems of *Calamagrostis canadensis*, Jun, year not stated, C. H. Peck (holotype NYS, isotype CUP-D as #104-14 & #82-130, isotype sent to NY in 1935). The holotype consists of 14 pcs of grass culm with ca 100 apothecia.

Hosts: On dead culms of previous years growth of large grasses. *Calamagrostis canadensis*; *Panicum virgatum* var. *spissum*; *Phragmites australis* (=*P*. *communis*); *Phalaris arundinacea*.

Range: Probably common throughout the Eastern U.S.A., but so far only known from New York.

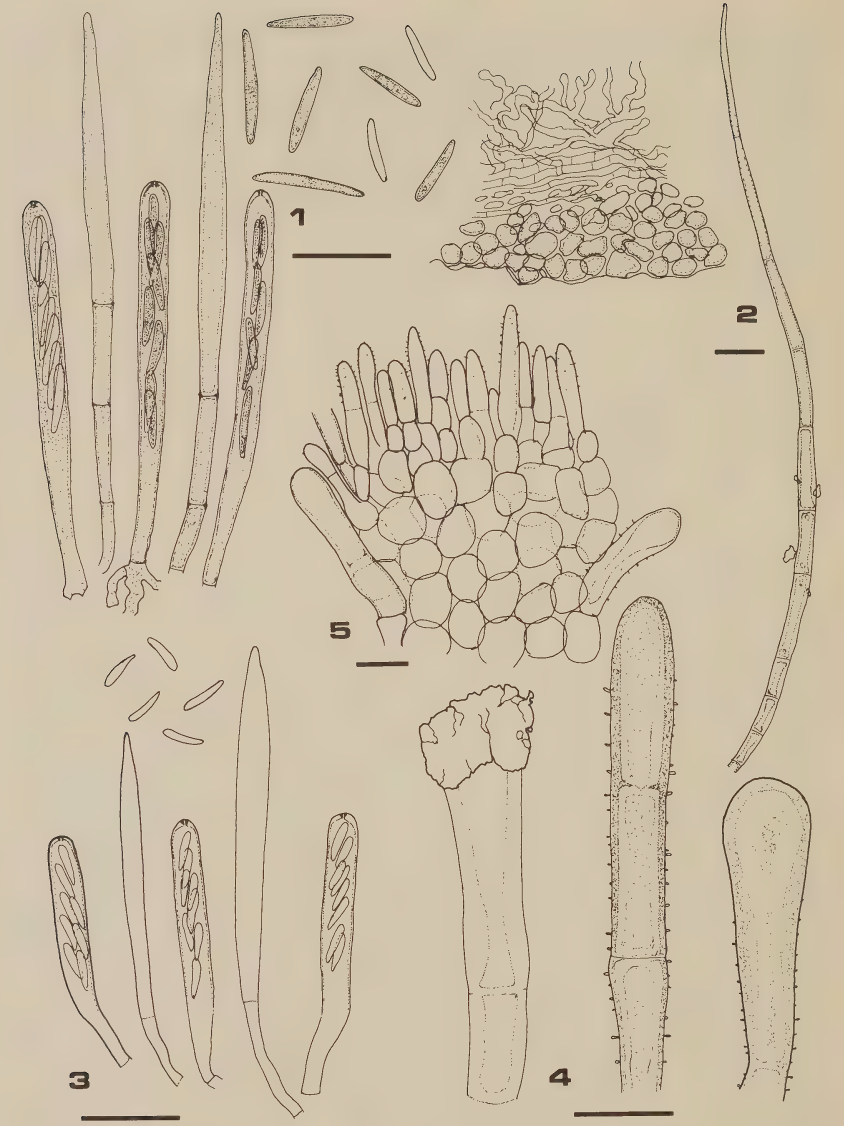
Specimens examined: U.S.A., New York, (see type); Suffolk Co., Wading River, on *Panicum virgatum*, Sep (no year given), C.H.Peck, as *Trichopeziza agrostina* (NYS, duplicate in CUP-D as 104-15); Albany Co., Bethlehem, Henry Hudson Park near W bank of Hudson River, on *Panicum virgatum* var *spissum*, 27 May 1970, Haines #1288 and S.J.Smith (holotype of *Albotricha longispora* NYS, isotype TAA); same as above but 11 May 1970, Haines 1128 (NYS); Herkimer Co., Cedarville Swamp ca. 1 mi S. of Cedarville, on *Calamagrostis canadensis*, 4 Jul 1970, Haines, S.J.Smith & C.T.Rogerson 1384 (NYS); Essex Co., Adirondack region, town of North Elba, North Meadow, on *Calamagrostis canadensis*, 23 Jul 1970, Haines 1438 & S.J.Smith (NYS); Essex Co., Adirondack region, Wilmington Notch, outlet of Malcolm Pond, on *Calamagrostis canadensis*, 23 Jul 1970, Haines 1448 & S.J.Smith (NYS); Warren Co., Adirondack region, Town of Warrensburg, Pack Experimental Forest, 8 Jun 1972, Haines 2050 (NYS); Cayuga Co., Montezuma game refuge, on *Phragmites australis*, 15 Jun 1972, Haines 2110 (NYS); Warren Co., Town of Warrensburg, in power line right-of-way, 2 mi N of Warrensburg, on *Calamagrostis canadensis*, 6 Jul 1972, Haines 2293 (NYS); Essex Co., Adirondack region, Keene Valley, on Gramineae, 12 Jul 1972 Haines 2321 (NYS); Essex Co., Adirondack region, meadow E of Wilmington, on *Phalaris arundinaceae*, 13 Jul 1972, Haines 2335 (NYS); Genesee Co., Bergen Swamp, on *Phragmites australis*, 18 Jul 1972, Haines 2356 (NYS); Albany Co., Albany Pine Bush, on Gramineae, 20 Jun 1978, Haines 3298 (NYS); Albany Co., town of Bethlehem, Henry Hudson Park near the W bank of the Hudson River, on *Phragmites* australis, 27 Jun 1978, Haines 3318 (NYS); same as previous collection but on Phragmites australis, 20 Jul 1979, Haines 3368 (NYS); Rensselaer Co., Rensselaer, under the E approach to the I 90 Bridge, on Phragmites australis, 24 Jul 1979, Haines 3376 (NYS); same as previous but on Panicum virgatum, Haines 3413 (NYS); Rensselaer Co., town of Sandlake, Taborton, on Gramineae, 22 May 1980, Haines 3426 & K.Conway, (NYS); Rensselaer Co., ca 5 mi E of Poestenkill, 22 May 1980, Haines 3455 (NYS); Washington Co., Eldridge Swamp ca 2 mi NE of Cambridge, Haines 3520 (NYS); Renselaer Co., Rensselaer, near the E approach to the I 90 bridge, on Phragmites australis, 10 Jul 1980, Haines 3756 (NYS); Albany Co., Albany riverfront, on Phragmites australis, 10 Jun 1986, Haines 3799 (NYS); Schenectady Co., along the old Erie Canal towpath ca 2 mi SE of Rotterdam Jct., on Phalaris arundinacea, 10 Jul 1986, Haines 3827 (NYS); Essex Co., Adirondack region, town of North Elba, South Meadow, on Calamagrostis canadensis, 16 Jul 1986, Haines 3852 (NYS); New Jersey, Newfield, on Andropogon, Jun 1889, J.B.Ellis, (as Ellis & Everhart, North American Fungi 2630) (NYS); Kansas, Manhattan, on Phragmites australis, Jun 1887, W.A.Kellerman (as Ellis & Everhart, North American Fungi #2038) (NYS).

Discussion. The variety, agrostina, is similar in macroscopic appearance to the type variety, but it differs by having spores measuring 7-18.5 µm instead of 6-9 µm as in authentic Desmazieres material of P.albotestacea ex M.A.Curtis herbarium now at NYS. All of the North American collections originally identified as Trichopeziza albotestacea (Desm.) Sacc. at the New York State Museum have spores longer than those of the type variety. This fact and the existance of Desmazieres' earlier species was apparently unkown to Peck as he described Peziza agrostina. Likewise, Raitviir was apparently unaware of Peck's P. agrostina when he described his Albotricha longispora from a modern collection made no more than 10 mi from Peck's type locality. The species, Trichopeziza albotestacea is readily distinquishable from other species of discomycetes on gramineae by its long, pink-buff hairs and cream-yellow disc.

The authors placement of this taxon in the genus Trichopeziza is based on the decision that the species is not congeneric with Albotricha acutipila (Karst.) Raitv., the type of Albotricha which has smooth, thin-walled hairs tapered to a fine point and thin-walled cells in the ectal exciple. Instead, it appears to be congeneric with Trichopeziza sulphurea, the type of Trichopeziza, which has slightly thick-walled hairs with loose granules, hemispherical apices and thick-walled cells in the ectal exciple. This opinion is not shared by Dr. Raitviir who wishes to retain *P. agrostina* as a species distinct from *P. albotestacea* and to retain both in the genus *Albotricha.* The name *Belonidium* which has, until recently, been used for this group of species has been replaced by Fuckel's name *Trichopeziza* for all but the type species, *B. aeruginosum*, which is referable to the genus *Lachnum* (Raitviir 1987).

Lachnella bicolor Peck, New York State Mus. Bull. 54:157. 1902.
non =*Lachnella bicolor* (Pat. & Demange) Locquin, Bull. Soc. Mycol. France 68: 166. 1952.
nec =*Lachnella bicolor* (Bull.: Fr.) Phill., Brit. Discomyc. p.249. 1889.

This unfortunate epithet was a latter homonym of the very common *Lachnella bicolor* (Bull.: Fr.) Phill. = *Lachnum bicolor* (Bull.: Fr.) Karst. when published, and at the same time a taxonomic synonym of the equally common *Trichopeziza leucophaea* (Per.) Rehm. Peck's name has apparently never been transferred and only a single specimen bearing that name is in the Peck herbarium. That specimen, marked "type" matches the type description and is on *Phytolacca decandra* collected near Snyder's Corners, Rensselaer Co., NY, 9 Aug 1900. However, the same species, now identified as *Trichopeziza leucophaea*, is represented by more than 20 additional specimens in the NYS herbarium. Several of these were made by Peck himself. One of the problems in the identification of this fungus is that the hairs change from bright yellow to grey-white with reddish brown resinous bodies. The number, size and location of this resinous matter determines the color of the dried specimen. In addition to the colored excipular hairs, Peck's type collection has hyaline hairs near the base which also attach to the substrate. This is a common , but not consistant, feature found in this taxon. It is this feature which led Peck to believe that this was a new species and to call it bicolor for the two colors of hairs. The basal mycelium is not to be confused with a subiculum in which the apothecium is seated entirely on a mat of hyphae as opposed to this instance in which the hyphae surround the apothecial base which is attached to the substrate.



Figs. 1–5. Trichopeziza albotestacea var. agrostina (Holotype). 1. Spores, asci and paraphyses. 2. Hairs and apothecial section. Lachnum capitatum (Lectotype). 3. Asci, paraphyses and ascospores. 4. Hairs. 5. Excipular margin.

Lachnum capitatum (Peck ex Thümen) Svrcek, Ces. Mykol. 39: 214. 1985. (as L. capitatum Peck) Figs. 3-5, 26.

Basionym: Peziza capitata Peck ex Thümen, Mycoth. Univ., Cent. IX, No. 813. 1877. (diagnosis on label)

=Trichopeziza capitata (Peck ex Thümen) Sacc., Syll. Fung. 8: 417. 1889.

=Dasyscypha capitata (Peck ex Thümen) LeGal, Rev. Mycol. N. S. 4: 29. 1939.

=Incrucipulum capitatum (Peck ex Thümen) Baral & Krieglst., Beih. Z. Mykol. 6: 72. 1985.

=Dasyscypha scintillans Massee, Brit. Fung. Fl. 4: 328. 1895.

This taxon is distinctive in having short, white, thick-walled, crystal-capped hairs and in being found on leaves of Quercus. It is one of Peck's best known hyaloscyphaceous species. It has been redescribed and illustrated by numerous authors (LeGal 1939, Kanouse 1947, Dennis 1949, Ellis & Ellis 1985), but it appears that the type specimen and authorship have been misinterpereted. Peck first collected this species in 1876 in Bethlehem, NY not far from Albany and made a complete description for publication in his annual report for that year. The publication, however, was delayed and did not get distributed until September of 1878 (Petersen 1980). In the interim, in 1877, he made a second, larger collection in Albany and sent it with his notes to F. Thümen for inclusion in his exsiccati, Mycotheca Universalis. Thümen's printing and distribution was much faster and the first publication of the species with a complete description appeared in 1877 on the cover of Mycotheca Universalis #813, at least 8 months before Peck's. This has a greater implication than just the date and author citation. Thümens packet and description refer to Peck's 1877, Albany collection, not the one he intended in his own publication to be the type. Fortunately the two specimens are conspecific, but since the "type" is now an exsiccatum which is divided into many portions and distributed throughout the world, lectotypification is necessary. I chose that portion of Mycotheca Universalis #813 deposited at NYS as Lectotype of Peziza capitata Peck ex Thümen. The lectotype specimen contains a single, complete, unbroken leaf with several hundred slightly immature apothecia.

Specimens examined: U. S. A., NY, Albany, on leaves of

Quercus *alba* L., 1877, C.H.Peck distributed as Thümen, Mycotheca Universalis #813 (lectotype NYS, duplicate not sent to Thümen isotype NYS); Albany Co., Bethlehem, on leaves of *Quercus* *alba*, Jun 1876, Peck (the specimen originally intended by Peck to be the type NYS); Rensselaer Co., Sandlake, on leaves of Q. *prinus* L., Jun, Peck (NYS); Catskill Mts., on leaves of Q. *rubra*, Peck (NYS); Albany Co., Albany Pine Bush region, on leaves of Q. *ilicifolia* Wang, Jun 20, 1978, Haines 3292 (NYS); Same as previous collection but on leaves of Q. *alba*, Haines 3292 (NYS); NJ, Newfield, on "oak leaves, Sep 1876 (as" *Peziza* *cephalotricha* Ell. mss") (NYS); Ohio, Lancaster, Fairfield Co., Jun 20, 1883, W. A. Kellerman 329 (NYS).

Cistellina *chamaeleontina* (Peck) Haines **comb. nov.** Fig 6.
Basionym; *Peziza* *chamaeleontina* Peck, Annual Rep. New York State Mus. 30: 60. 1878.
=*Dasyscypha* *chamaeleontina* (Peck) Sacc., Syll. Fung. 8: 1889.
=*Atractobolus* *chamaeleontinus* (Peck) O. Kuntze, Rev. Gen. Plant. 3: 445. 1898.

Apothecia .10 - .25 mm in diam., cup-shaped with a short cylindrical stipe ca .1 mm long, scattered on exposed, rotted wood of the host, white, changing to yellow then pinkish or red when bruised (according to Peck), now transluscent orange-yellow in dried material, covered with very short, yellow hairs. **Ectal excipulum** very thin, composed of parallel hyphae laying at a close angle to the surface, forming *textura* *primatica* with swollen cells up to 10 X 5 µm. Ends of the hyphae protrude to form rudimentary hairs. **Hairs** up to 30 X 2 - 3 µm, clavate, sparsely roughened on the apical half, smooth below, often slightly curved, non-septate, thin-walled. **Asci** 20 - 40 X 3 - 4 µm, cylindric-clavate, often subtended by a crozier, with a short, tapering, cylindrical apical pore ca 1 µm in diam. which stains bright blue in IKI (1% IK) without KOH pretreatment, no red reaction observed. **Spores** 4.0 - 5.5 X 1.3 - 2.3 µm, ovate to ovate ellipsoid (pyriform in strongly osmotic mounts), non-septate, with 1 or more inclusions at each end, occasionally enveloped in what appears to be a thin, hyaline gel layer about .3 µm thick. **Paraphyses** up to 2.5 µm thick, very slightly longer than the asci, slightly tapered to a blunt apex.

Type: U.S.A., NY, Rensselaer Co., Sand Lake, on decorticated wood of Hemlock (*Tsuga* *canadensis*), Nov (year not stated), C. H. Peck. The specimen consists of about 18 carved chips of wood with a total of more than 100 apothecia. (holotype NYS, Isotype in CUP-D).

Hosts: On the underside of a decorticated log of *Tsuga canadensis*.

Range: Known only from two New York collections made about 150 mi apart. It is such an inconspicuous fungus that it could easily be overlooked, and it could prove to be more widespread.

Specimens examined: U.S.A, NY (see type); Tompkins Co., Enfield, on wood, 19 Oct 1894, E.J.Durand (CUP-D); Tompkins Co., Fall Creek near Ithaca, 23 Oct 1894 (CUP-D)

Discussion: This appears to be a good species closely related to *Cistellina hymeniophila* (Karst.) Svrcek (=*Peziza stereicola* Cooke). It is recognized by its small, nearly smooth, orange yellow when dry, distinctly stipitate apothecia, its ectal exciple composed of parallel hyphae lying at a low angle to the surface and its small ovate spores. Peck recorded, a tendency for it to change from white to yellow and "pink rhubarb" or red when bruised. These features set it apart from other small discomycetes known to the author. It differs from *C. hymeniophila* by its lignicolous rather than fungicolous habitat. The genus *Cistellina* was proposed for *Cistella*-like fungi in which the exciple is composed of parallel hyphae.

Lachnella citrina Peck, Annual Rep. New York State Mus. 46: 35. 1893. Figs. 9-11.

Apothecia up to .6 mm across when dry, cyathiform, short stipitate, buff to orange buff, thickly covered with buff-yellow hairs which curve upward along the cup, and which turn olive-grey in older specimens. Some apothecia are almost white as noted by Peck in his original description. The olive pigment changes to red droplets then disperses and the excipulum becomes transparent when placed in 3%KOH. Disc slightly darker, concealed by marginal hairs in dried specimens. **Ectal excipulum** hyaline *textura prismatica* composed of thin-walled cells. **Hairs** up to 100 µm long by 2.5 - 3.0 µm wide, irregularly cylindrical or slightly tapered to a hemispherical tip, 0-, 1- or 2-septate, slightly thick-walled, walls up to ca. 1

μm thick, faintly yellow-pigmented, coarsely roughened with tightly adhering, uniform-sized granules ca .5 μm. **Asci** 55- 65 X 6.0-7.5 μm, cylindrical with hemispherical tip and tapered base lacking crozier, no pore detected with or without stains, 8-spored. **Spores** 7-12 X 2.5-3.0 μm, ellipsoid-fusiform, slightly more tapered in the lower half, non-septate. **Paraphyses** filiform, 1.0-1.5 μm in diam., not superceeding the asci in the hymenium.

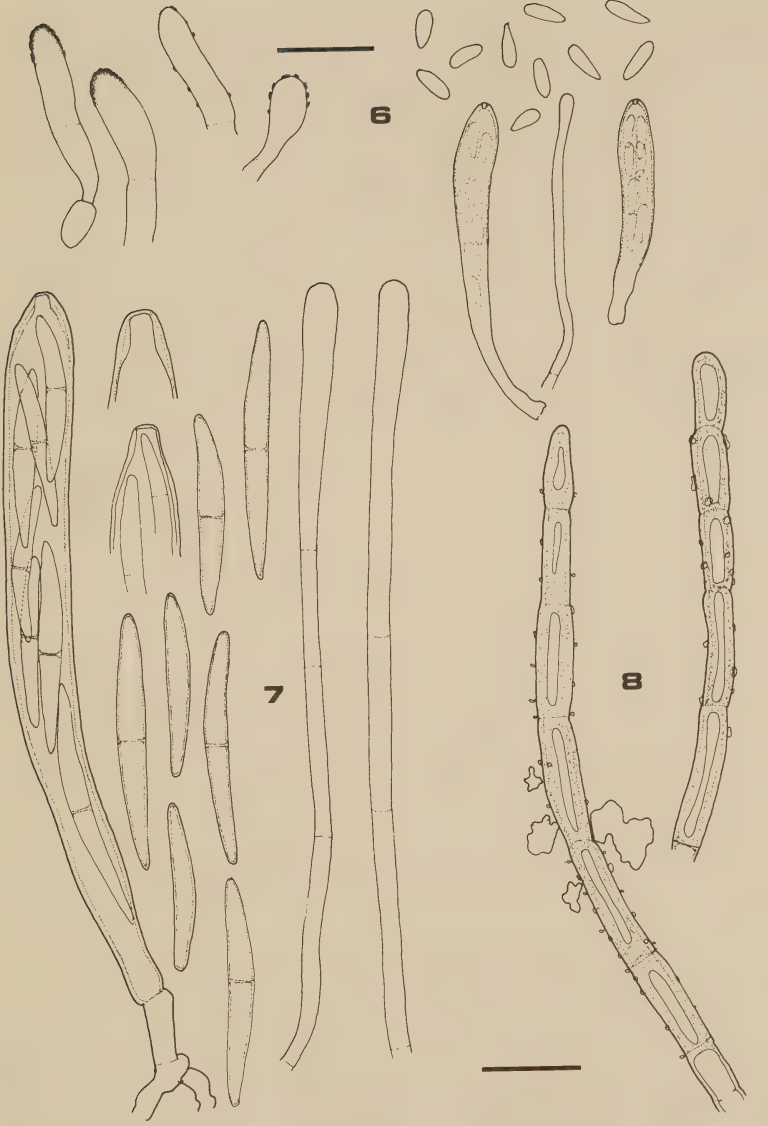
Type: U.S.A., NY, Ulster Co., Shokan, on bark of living chestnut tree, Sep 1892, C.H.Peck (holotype NYS, isotype CUP-D 82-43). The holotype consists of 7 pcs of chestnut park with over 100 apothecia.

Host: Known from the bark of living or recently killed American chestnut (Castanea americana) and Quercus and Acer spp.

Range: Known only from three widespread locations in New York.

Specimens examined: U. S. A. New York, (see type); Bolton Landing, Warren Co., 23 Aug, probably 1901, C. H. Peck (NYS); Coy Glen, near Ithaca, Thomkins Co., on living chestnut, Nov 20, 1894, E. J. Durand 631 as Dasyscypha turbinulata (NYS, CUP-F, CUP-D as 82-35); Coy Glen, on living chestnut, 9 Mar 1901, E.J.Durand (CUP-D 82-36; Coy Glen, on living chestnut, 11 Dec 1901 (CUP-D 82-47); West Shore of Cayuga Lake, on chestnut, 12 Oct 1901, E.J.Durand (CUP-D); New Jersey, Newfield, on bark of living Quercus coccinia, 1887, M. B. Ellis (NY); Pennsylvania, Bethlehem, Oct 1880, M. B. Ellis & H. W. Harkness, also distributed as North American Fungi #564, Ellis Collection (NY); North Carolina, Blowing rock, bark of living chestnut, Aug 1901, E.J.Durand 1226 (CUP-D 82-34, CUP-F).

As Rehm (1907) points out, Peck's Lachnella citrina is the same as Schweinitz's earlier Peziza turbinulata, a fortunate occurrence, since the specific epithet "citrina" is preoccupied in many hyaloscyphaceous genera. No holotype for P. turbinulata could be located in the Schweinitz collections at Philadelphia by Seaver according to notes at the New York Botanical Garden, but a later collection from the type locality and host fits the description well and was used to represent the species. It has apparently not been collected since around the turn of the century a fact which may be tied to the decline of its american chestnut host. Even though it is a small,



Figs. 6-8. *Cistellina chamaeleontina* (Holotype). 6. Hairs, asci, paraphyses and ascospores. *Perrotia distincta* (Holotype). 7. Asci, ascus tips, ascospores and paraphyses. 8. Hairs.

inconspicuous fungus, its olive-grey coloration when dried, and the absence of a pore at the ascus tip makes it distinctive and unlikely to be overlooked for long. The same, distinctive lack of pore that makes it easy to recognize, makes it difficult to place taxonomically. Within the Hyaloscyphaceae, *Perrotia* is similar in having pore-free asci, but it differs from *P. flammea* (Alb. & Schw.) Boud., the type of *Perrotia*, in exciple and hair characters, it bears a closer resemblance to *P. populina* (Seaver) Dennis. Raitviir (pers. comm.) has suggested that it needs a new genus, but for the present no new taxon will be described.

Seaver (1951) suggested a possible synonomy of this species with *Lachnella albolutea* (Pers.) Karst., but this most commonly refers to a species with a distinct ascus pore, smooth hairs and sessile apothecieum.

Perrotia distincta (Peck) Haines **comb. nov.** Figs. 7,8,28.

Basionym: *Peziza distincta* Peck, Annual Rep. New York State Museum 30: 60. Sep 1878.
=*Trichopeziza distincta* (Peck) Sacc., Syll. Fung.8: 421. 1889.
=*Patellaria aureococcinea* Berk. & Curt. in Ellis, N. Amer. Fungi, Cent I, #63. 1978. (nomen nudum).
=*Helotiella aureococcinea* Massee, J. Linn. Soc. 35: 108. 1901. (First valid publication).
=*Solenopeziza aureococcinea* (Massee) Rehm, Ann. Mycol. 2: 352. 1904.
=*Dasyscypha phragmiticola* P. Henn. & Ploettn. Verh. Bot. Brand. 41: 97. 1899.
=*Lachnellula phragmiticola* (P. Henn. & Ploettn.) Boud., Hist. Classif. Discom. Europe p. 124. 1907.
=*Lachnella phragmiticola* (P. Henn. & Ploettn.) W. Kirschst., Ann. Mycol. 34: 182. 1936.
=*Perrotia phragmiticola* (P. Henn. & Ploettn.) Dennis, Kew Bull. 17: 357. 1963.

Apothecia up to 1.5 mm in diam. when fully expanded, scattered or gregarious on substrate, salviform when moist, cyathiform when dry or with the margins infolding to become hysteriform, narrowed to a central point of attachment below, not distinctly stipitate, sometimes with a small weft of anchoring hyphae, black and nearly smooth externally, covered at the margin with buff to ochraceous-buff to yellow hairs, darkening slightly when dry. Disc pink to orange-vermillion when fresh, darkening to orange-ochraceous on drying, exposed even in dried specimens. **Ectal excipulum** of two distinct layers. The outer layer which gives rise to the hairs is of 1-3 cells thickness composed of dark red-brown (golden brown with transmitted light), thick-walled, subglobose or irregular cells 5-10 µm in diam., forming textura globulosa to epidermoidea. The cells of the inner layer are similar but are hyaline and even thicker-walled so that the lumen is confined to a small central cavity so that the tissue looks like the sclerenchyma of higher plants. **Medullary excipulum** of thick-walled, textura intricata. **Hairs** up to 150 µm long by 3-5 µm in diam., irregularly cylindrical, or tapering slightly toward the tip in the longer examples, with hemispherical tips which may be slightly enlarged in shorter examples, rarely branched near the base, septate with septa forming cells 7-15 µm long, thick-walled with the walls up to 2 µm thick and the lumen sometimes reduced to a narrow channel, golden brown with transmitted light, sometimes with nearly hyaline tips, smooth but with occasional lumps of yellow to brown resinous-appearing matter adhering to the surface especially near the tips, up to 2 µm in diam. **Asci** (55-)60-75(-90) X 5-7 µm, cylindrical with conical apices and tapered bases, usually subtended by croziers, without a trace of apical pore or plug, not reactive with Melzers' reagent or IKI, with or without KOH pretreatment, 8-spored. **Spores** (16-)18-22(-25) X 2-3 µm, elliptic-fusiform, straight or slightly curved, becoming 1-septate while still in the ascus, very slightly enlarged in the upper half, otherwise symmetrical about the polar axis, hyaline. **Paraphyses** up to 3 µm wide at the widest point, cylindrical 1-2 µm below expanded to clavate upper portion with a blunt apex, 2-3 µm wide, septate below, superceeding the asci by up to 10 µm in the hymenial arangement.

Type: U.S.A., NY, Albany Co., Center (now known as Karner in the Albany Pine Bush region), on dead culms of Andropogon furcatus, Oct. 1876, C. H. Peck [holotype in NYS; Isotype in CUP-D as #5696 (90-63) is a small collection in good condition. A second isotype was sent to NY in 1935]. The holotype consists of 30 plus pcs of grass culm with more than 200 apothecia.

Hosts: Andropogon furcatus; Phagmites communis; Panicum virgatum var. spissum. Occurring on last years culms, late in the growing season (Oct. and Nov.) in North America.

Range: Apparently widespread in temperate regions in Europe, the British Isles and North America, but not commonly collected, perhaps because of its late sesonal occurence and relative rarity.

Specimens examined: German Democratic Republic, near Rathenow, Nov 1889, Plottner (type of Dasyscypha phragmiticola (K); U.S.A., NY, (see holotype); South Carolina, on Andropogon, M.A.Curtis, (NYS ex Curtis herbarium, presumed isotype material of Patellaria aureococcinea); England, Norfolk, on Phragmites, Oct 1978, A.Moore (as Perrotia phragmiticola, K); Surrey, Black Pond, Eshe Common, 3 Nov 1985, B.Spooner (as Perrotia phragmiticola, K); Isle of Arran, Kildoron, on Phragmites, 24 Sep 1981, R.W.G.Dennis (as Perrotia phragmiticola, K); U.S.A., Kansas, Rooks Co., 22 Oct 1892, E.Bartholomew #3001 (CUP-D, #90-62); Louisiana, Lafayette, on Andropogon, 12 Nov 1889, Langlois #2253 (CUP-D 8255, 90-64); New Jersey, Newfield, on Andropogon, Oct, J.B.Ellis (NYS; also as Ellis, North American Fungi #63); New York, Albany Co., Cedar Hill near the W bank of the Hudson River, on Panicum virgatum var spissum, 3 Nov 1969, Haines 1114 & S.J.Smith (NYS); Albany Co., Albany Pine Bush, on Gramineae, 18 Oct 1977, Haines 3273 (NYS); Bronx Co., Bronx, on grounds of the New York Botanical Garden, on Andropogon virginicus, 23 Nov 1985, C.T.Rogerson 85-119 (NY, NYS); Orange Co., Harriman State Park, vicinity Raymond Torrey Monument, on Phragmites australis 6 Nov 1979, C.T.Rogerson (NY, NYS); Suffolk Co., Long Island, Riverhead, Sweezy Pond, on Panicum virgatum var spissum, 6 Oct 1971, S.J.Smith #47460, C.T.Rogerson & E.C.Ogden (NYS).

Discussion: As indicated by Peck's name for this fungus, it is very distinctive, but apparently somewhat rare. It is distinct in having a pinkish disc surrounded by yellow to brown hairs. The colors of both the hairs and the disc are variable and prone to change on drying and during the lifespan of the apothecia under natual conditions. Microscopically it is distinct in having nearly smooth, thick-walled hairs and in lacking an apical ascus pore. The ascus tip is similar to that found in Perrotia populina (Seaver) Dennis (Haines & McKnight 1977). Synonymy with P. phragmiticola is based on comparisons of type material and is reported here for the first time. Synonymy with Solenopeziza aureococcinea has been reported before and it would create a problem as to which species has priority as they were both used in 1878, but the latter was published as a nomen nudum without diagnosis as #63 in the first century of J. B. Ellis's North American Fungi. The diagnosis was finally provided by Massee in 1901, thereby clearly giving Peck's species priority. One has only to look at the list of genera in which this species has been placed to see that it has been a conundrum for those who have known it. Its subglobose, pigmented outer excipular cells, thick-walled hairs, clavate paraphyses and lack of a pore plug make Perrotia a clear choice at this state of our taxonomic knowledge.

Pezicula kalmiae (Peck) Sacc., Syll. Fung. 8: 314. 1889.
Basionym: Peziza kalmiae Peck, Annual Rep. New York State Mus. 25: 99. 1873.
=Dermatea kalmiae (Peck) Ellis & Everh., North American Fungi #147. 1879.
=Trichopeziza kalmiae (Peck) Sacc., Syll. Fung. 8: 411. 1889.

Type: U.S.A., NY, Rensselaer Co., Sandlake, on old stroma of the fungus Phyllachora kalmiae (Peck) Petrak which was growing on the small branch tips of Kalmia angustifolia, C.H.Peck, no date, (holotype NYS, isotype CUP-D 104-48). The holotype consists of one branching twig and one small fragment both mounted on small portions of herbarium sheet. Together they bear ca 30 apothecia.

Hosts: The fungus Phyllachora kalmiae on Kalmia angustifolia

Range: Known, with certainty, only from New York and Maine.

Specimens examined: USA, New York (see type); Maine, Kittery Point, on Kalmia, R. Thaxter (CUP-D 104-49).

Discussion: The type has an exciple composed of brown, small-celled textura angularis and ovate ascospores ca. 8.0 X 3.5 µm. It is definitely not hyaloscyphaceous and appears to be a member of the Dermatiaceae. The specimen distributed as Ellis' North American Fungi #147 was misidentified and was subsequently made the type of a new species, Gorgoniceps kalmiae, by Rehm (1904).

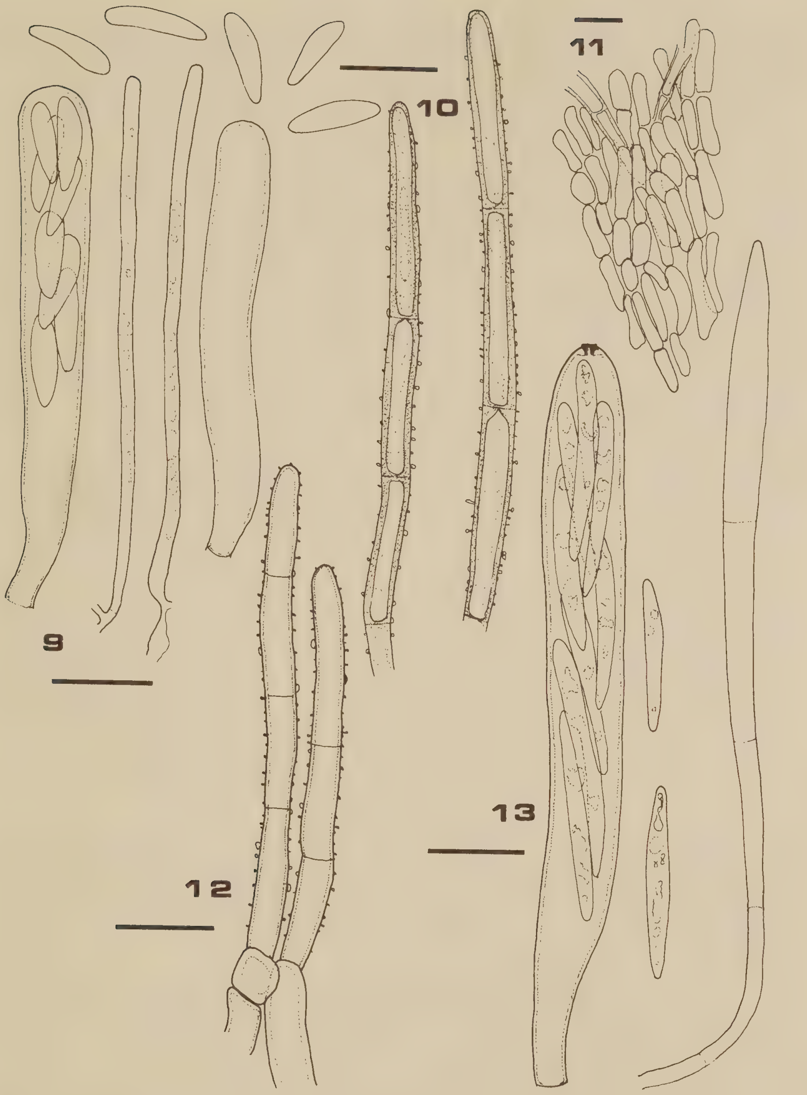
Peziza longipila Peck, Annual Rep. New York State Mus. 32: 46. 1879.

=Trichopezizella relicina (Fr.) Raitv., Scripta Mycol. 1: 60. 1970.

This species and its synonymy with T. relicina has been fully discussed previously by the author (Haines 1974). Although this species is relatively common in some areas, it is apparently rare in the territory known to Charles Peck and his type specimen of P. longipila remains today as the sole example known to the author from New York state. In addition to "normal" apothecia, the type collection contains several similar fruiting bodies in which the hymenium is replaced by what can be assumed to be the anamorphic state. This phenomenon is not uncommon in members of the Hyaloscyphaceae, but, unfortunately in this case the collection is very small (about a dozen poorly preserved apothecia) and the anamorph, which appears to have a phialidic type of conidial production, is immature. Spooner (1987) synonymizes Trichopeziella Raitv. with Lasiobelonium Ellis & Everh., on the basis that the smooth haired-species of the former intergrade with the rough-haired species of the latter. The present author maintains that the two are separable on the basis of hair granulation and the intensity of hair pigmentation, and retains both genera.

Lachnum luteodiscum (Peck) Haines **comb. nov.** Figs. 12,13.
Basionym: Peziza luteodisca Peck, Annual Rep. New York State Mus. 33: 31. 1881.
=Dasyscypha luteodisca (Peck) Sacc. Syll. Fung. 8: 449. 1889.
=Atractobolus luteodiscus (Peck) O. Kuntze, Rev. Gen. Plant. 3: 445. 1898.
=Pezizella albidorosea Rehm in Rabenh., Kryptogamenfl. 1(3): 682. 1896.
=Mollisiella albidorosea (Rehm) Boud., Hist. Classif. Discom. Europe p. 142. 1907.
=Dyslachnum albidoroseum (Rehm) Hohn., Mitt. Bot. Lab. Techn. Hochsch., Wien 3: 71. 1926.
=Lachnum albidoroseum (Rehm) Nannf., Ann. Mycol., Berl. 34: 397. 1936.
=Dasyscyphus albidoroseus (Rehm) Dennis, Comm. Mycol. Inst., Mycol. Pap. 32: 30. 1949.

Apothecia up to 1 mm in diam. when fully expanded, scattered on substrate, buff white, covered with short, white to rose-colored hairs, short stipitate, stipe ca. 0.1 mm in diam., shorter than the diameter of the disc, disc



Figs. 9-13. Lachnella citrina (Holotype). 9. Asci, paraphyses and ascospores. 10. Hairs. 11. Excipular surface. Lachnum luteodiscum (Holotype). 12. Hairs. 13. ascus, ascospores and paraphyses.

circular, flat, orange-buff to orange chrome drying to scarlet vermillion, exposed even in dried specimens. **Excipulum** not differentiated into definable layers, composed of short, slightly inflated-celled, hyline _textura prismatica_. **Hairs** of two types, excipular and marginal. The excipular hairs up to 60 µm long by 3-4 µm wide, cylindrical, with hemispherical tips, arising from a short chain of enlarged excipular cells, flexuous, hyaline or very slightly rose-colored in some specimens, sparingly septate, thin-walled, evenly and copiously roughened with coarse, hyaline granules ca. 0.7 µm in diam. which appear to be slightly taller than broad. The marginal hairs, which arise from the ends of the cells making up the margin, up to 70 µm by 2.5-3.5 µm, cylindrical or sometimes slightly tapered to 2-3 µm rounded tip, hyaline to buff, closely septate forming cells ca. 15 µm long, almost smooth, but some with a few adhering granules, very similar to paraphyses in some instances. **Asci** 55-70 X 6-8 µm, cylindrical with tapered base and slightly conical apex, lacking croziers, with distinct pore visible without staining, blue reaction in IKI with or without KOH pretreatment, 8-spored. **Spores** (12.5-)15-19(-20) X 2.5-4.0 µm, elliptical-fusoid, slightly tapered in the lower half, with rounded tips, straight or very slightly curved, usually non-septate, but occasionally with a single, median septum. **Paraphyses** lanceolate, 2.0-3.5 µm diam. at the widest point about one forth down from the tip, filiform with enlarged, clavate tip, superceeding the asci by less than 10 µm in the hymenial arrangement.

Type: U.S.A., NY, Manlius, on dead stems of _Scirpus validus_, Aug. 1879, C. H. Peck (holotype at NYS contains ample substrate, but only a few dozen apothecia and those are interspersed with _Mollisia_ sp.; isotypes sent to NY in 1935 and CUP-D).

Hosts: _Scirpus lacustris_; _S. acutus_; _S. validus_; _Juncus effusus_; On the bases of overwintered flower stalks.

Range: Apparently widespread, but not common in the Northeastern U. S. A. and in Europe and the British Isles.

Specimens examined: U. S. A., NY, (see type); Genesee Co., Bergen Swamp, on _Scirpus acutus_, 14 Sep 1964, C. T. Rogerson, S. J. Smith & R. DeGroot (NY; and as JHH 1475 NYS); Bergen Swamp, on _Scirpus acutus_, 19 Jul 1972, Haines 2397 & 2379, S.J.Smith & C.T.Rogerson (NYS); New Jersey, Iona, on Juncus effusus, Aug, Carrie & Emma Bradley, leg. J. B. Ellis as "Peziza (Dasy.) paraphysata Ell" (NYS); A portion of what is apparently the same colection was also issued as J. B. Ellis, North American Fungi #441 as "Peziza luteodisca, Pk., in literis" (NYS).

Discussion: This is a very distinctive, but not commonly collected species, a fact which has led to its being decribed as new by several authors. As far as this author is aware, Peck was first to do so, with J. B. Ellis ready to describe it again as "Peziza paraphysata", even before Pecks name was in print. Fortunately the two authors were in correspondence and the situation was resolved with Ellis shelving his name in favor of Pecks prior to its valid publication.

Dasyscypha clavispora Mouton is a similar, large-spored species on grasses and rushes. Authentic material from Moutons herbarium was examined and compared with Pecks L. luteodiscum. Moutons species differs in having more distinctly clavate spores, cylindrical, non-lanceolate paraphyses 1.5-2.0 µm wide and finely granulate hairs. Its hair and apothecium color is difficult to determine from the scanty authentic material remaining. Dennis (1962) has reported D. clavisporus from Britain, but it has not yet been reported from outside of Europe. Despite its filiform paraphyses, it is a Lachnum in all other respects and its transfer to that genus is made here.

Lachnum clavisporum (Mouton) Haines, **comb. nov.**

Basionym: Dasyscypha clavispora Mouton, Bull Soc. Roy. Bot. Belgique 36: 18. 1897.

Only one collection labelled D. clavispora remains among the Mouton material at Bruxelles (BR), and that is reduced to one mounted and one unmounted apothecium. This packet, now mounted on a sheet marked "TYPE" with a recent label, states that the substrate is "Agrostis" which apparently corresponds with its contents. This host information does not, however, correspond with that in the protologue which names Molinia and Juncus conglomeratus as its substrate. Regardless of whether this specimen is the type or not, it appears to be the only authentic material left, and it is used here to base the transfer of this species.

Lachnum myricacea (Peck) Haines **comb. nov.** Figs. 18,19.

Basionym: Peziza myricacea Peck, Annual Rep. New York State Mus. 30: 59. 1878. (As Peziza

(Dasyscypha) myricacea)
=Trichopeziza myricacea (Pk.) Sacc., Syll. Fung. 8:409. 1889.

Apothecia up to 1.0 mm in diam., widely scattered on substrate, deeply cup-shaped, covered externally with matted, flexuous, light brown hairs which show no trace of resin secretions at low magnification, nor undergo any color change when immersed in 3% KOH. Disc concave, white to very "pale luteus", covered by infolded cup margin and hairs when dry. Stipitate with a naked stipe much shorter that the diameter of the disc. **Ectal excipulum** of Textura prismatica composed of hyaline cells ca. 3 X 10 µm. **Hairs** up to 250 µm long by 3.5-5.0 µm wide, cylindrical, flexuous, with hemispherical, unswollen, concolorous tips, without resin or crystal accretions, often branched, kinked or swollen near the base, light brown with transmitted light, unchanged and without pigment release in 3% KOH, septate, with thin outer walls, and what appears to be a thicker, hyaline inner wall, roughened externally with moderately coarse granules 0.2-0.8 µm in diam. that sometimes become dislodged after immersion in 3% KOH followed by Melzer's soln. Short, irregular, light brown, one-celled hairs are interspersed among the longer ones. **Asci** (39-)45-55 X 4-5 µm, cylindrical, with apical pore blue in IKI croziers not observed, 8-spored. **Spores** (6.0-)6.5-8.0(-10.0) X 1.1-1.8(-2.5) µm, unequally fusiform, slightly more tapered in the lower half, usually straight. **Paraphyses** up to 5 µm across at the widest point, definitely lanceolate with acute apices, superceeding the asci by up to 25 µm in the hymenial configuration.

Type: U.S.A., NY, Adirondack Mts., on dead stems and branches of Myrica gale, Aug. 1876, C. H. Peck (holotype NYS; isotypes sent to NY & CUP-D). The holotype contains an ample amount of substrate but very few apothecia, and those are in poor condition, a fact noted by Seaver (1951). This may be due to the scattered occurance of the fruiting bodies in nature and their propensity for becoming dislodged from their substrate in old specimens.

Host: Myrica gale L. Known only from the fallen, bark covered twigs and stems of this species.

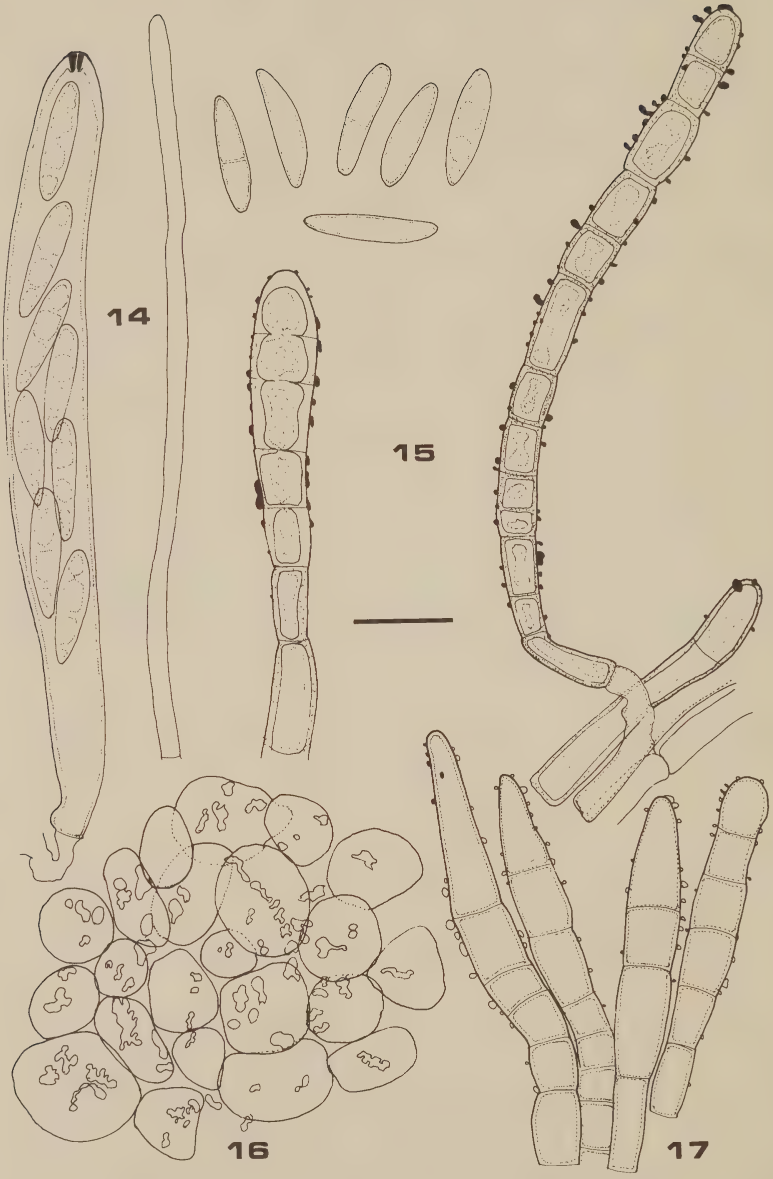
Range: So far known only from the Adirondack Mountains of New York, but it should be sought elsewhere in the range of Myrica gale.

Specimens examined: U.S.A., New York, (see type); Essex Co., Adirondack region, Lake Sallie (Lake Sally?), on Myrica gale, Aug, C.H.Peck (CUP-D 82-122, #9060); Grassy Pond, on Myrica gale, Probably Jun 1884, C.H.Peck (NYS); Essex Co., Adirondack region, Newcomb, on Myrica gale, 22 Jun 1923, H. D. House (NYS); Franklin Co., Adirondack region, Stoney Creek Ponds, Corey's, on Myrica gale, 5 Jun 1988, Haines #4038 (NYS); same as preceeding but 18 Jun 1988 Haines #4072 (NYS).

Discussion: This species is seldom encountered and its type collection is in poor condition so it is therefore, not well known. The six collections examined here are now enough to give a good concept of the species. It is a perfectly good Lachnum related to Lachnum clandestinum (Bull.) Fkl., but differs from that species by its its longer, hairs which lack resin secretions at the tips, its shorter stipe and restricted substrate. It is a species which has apparently not been illustrated or redescribed since its original publication. There is a single subsequent report of it in the literature (Jackson 1935) of a collection made by C. L. Shear near Inlet, NY in the Adirondack region in 1934. It was not reexamined, but there is no reason to doubt the report. A New Jersey collection by J.B.Ellis, Nov 1878, at NYS which bears the name Trichopeziza myricacea is misnamed.

Solenopezia solenia (Peck) Sacc. Syll. Fung. 8: 477. 1889. Figs. 14-17,29.
Basionym: Peziza solenia Peck, Bull. Buff. Soc. Nat. Sci. 1: 70. Jun 1873.
=Lachnella solenia (Peck) Seaver, N. Amer. Cup-fungi (inoperculates). p. 260. 1951.
=Dasyscyphus solenia (Peck) Dennis, Kew Bull. 17: 364. 1963.
=Belonidium solenia (Peck) Raitv., Scripta mycol. 1: 50. 1970.

Apothecia up to 0.5 mm diam., scattered to densely gregarius on substrate, often amongst other fungi, very deep cup-shaped, urceolate or soleniform, often slightly constricted at the mouth, height usually equal to or longer than diam., shape not changing significatly on drying, sessile, narrowed at the base to a small point of attachment, externally dark brown to almost black, sometimes with a purple tint, with a white fringe of hairs at the margin. Disc deeply concave, white to cream. Ectal



Figs. 14-17. Solenopezia solenia (Holotype). 14. ascus, paraphysis and ascospores. 15. Excipular hairs. 16. excipular surface. 17. Marginal hairs.

Excipulum thin, ranging from textua angularis near the base to short-celled textura prismatica near the margin, composed of brown, slightly thick-walled, cells, roughened on the exposed surface. **Medullary excipulum** hyaline Textura prismatica composed of thin-walled, elongate cells. **Hairs** of two types, excipular and marginal, excipular hairs up to 100 µm long, usually 40-60 µm, clavate, 3.0-4.5 µm below, expanding to 4.5-6.0 µm above, usually curved, closely septate with septa forming very short cells which are often no longer than they are wide in the swollen, upper portion of the hair, outer walls slightly constricted at the septa, thick-walled with what appears to be an inner wall layer up to 2.5 µm thick which reduces the cell lumen to less than half the hair width, brown below becoming hyaline in the swollen upper portion, with pigmented contents which may release a violaceous pigment in 3% KOH, externally smooth or with a very few concolorous granules. Marginal hairs usually ca. 40µm X 4-6 µm, cylindric clavate, closely septate, thin-walled, hyaline, externally covered in the lower portion with minute, regular granules up to 1 µm diam, the upper portions nearly smooth but with irregularly-shaped particles up to 2 µm diam. **Asci** (62-)70-85(-95) X 7.0-9.5 µm, cylindrical with slightly conical apex, tapered at the base, usually subtended by a crozier, pore clearly evident even in unstained material, blue in IKI, 8-spored, spores filling the entire ascus to within a few µm of the basal septum when mature. **Spores** (12.5-)14-17 X 3.0-3.5 µm, fusiform elliptic, slightly broader in the upper portion, straight or slightly curved, usually non-septate but occasionally 1-3-septate, containing 2-4 spherical inclusions, hyaline, smooth. **Paraphyses** 2-3 µm in diam., cylindrical with narrowly clavate tips, not superceeding the asci by more than a few microns.

Type: U.S.A., NY, Schuyler Co., Watkins Glen, "on dead stems of Eupatorium ageratoides in damp, shaded places" Sep 1871, C.H.Peck (holotype NYS; isotypes sent to NY, K & CUP-D). The holotype consists of about 20 pcs on stem with a total of more than 150 apothecia. The packet also contains 2 small drawings by Peck of microscopic detail

Hosts: Eupatorium maculatum L.(=E. purpureum var. maculatum); E. rugosum Houtt.(=E. ageratoides L.f.). Peck (1878) states that had only seen the fungus on E. ageratoides and never on E. maculatum, but it has subsequently been collected several times on the latter species. Apothecia found on previous years' stems lying in moist areas.

Range: So far known only from a few collections from widespread regions of New York.

Specimens examined: U.S.A., New York, (see type); Ulster Co., Big Indian, "Catskill Mts.", on *E. ageratoides*, C.H.Peck, Sep 1877 (NYS) also distributed as J.B.Ellis, North Amer. Fungi #384 (NYS), as F.de Thümen, Mycoth. Univ. 1114 (NYS) and in Clinton Herbarium sheet 44893 (BUF); Essex Co., Newcomb, on *E. purpureum*, H.D.House, 1115, 14 Sep 1925 (as *Dasyscypha leucostoma* Rehm) (NYS); Herkimer Co., swamp 1 mi S of Cedarville, on *Eupatorium maculatum*, 10 Sep 1970, Haines 1509, S.J.Smith & K.P.Dumont (NYS); Herkimer Co., cedar grove 1 mi S of Jordanville, on *Eupatorium maculatum*, 10 Sep 1970, Haines 1517, S.J.Smith & K.P.Dumont (NYS); Schuyler Co., Hendershot Gulf near Alpine, on *Eupatorium maculatum*, 19 Sep 1970, Haines 1551 on Peck Foray (NYS); Schuyler Co., Arnot Forest Camp SW of Ithaca, on *Eupatorium*, 20 Sep 1970, Haines 1563 on Peck Foray (NYS); W.R.Gerard (no collection data, but probably Poughkeepsie, New York ca. 1860) on *Eupatorium* sp. CUP-D 81-40 as *Peziza eupatorii* Schw.; USSR, Sakhalin Island, Kuznetsovo, 12 Sep 1979, A. Kollom (TAA 112768).

Discussion: Despite the fact that only a few collections of the fungus are known, it is a well known and well accepted taxon. The collection from Sakhalin Island, which was kinkly sent to the author by Dr. Raitviir, is geographically far removed from the other specimens known to the author, but it is identical in all other respects to the New York Material. The species has been described and illustrated by Peck (1873, 1878), Seaver (1951), Dennis (1963) and Raitviir (1973). Saccardo included it along with seven others in a new genus, *Solenopezia*. The genus was apparently based on the sessile nature of the fruiting bodies and their two-celled spores. Those characters are not enough to hold Saccardo's species together, but after Nannfeldt (1932) redefined the genus and lectotypified it with *S. solenia*, it has been accepted by most workers at least as a monotypic genus.

Calycella subochracea (Cooke & Peck) Dennis, Kew Bull. 17: 366. 1963.

Basionym: *Peziza subochracea* Cooke & Peck, Grevillea 1: 6. 1872 (as *Peziza* (Dasyscypha) *subochracea*).

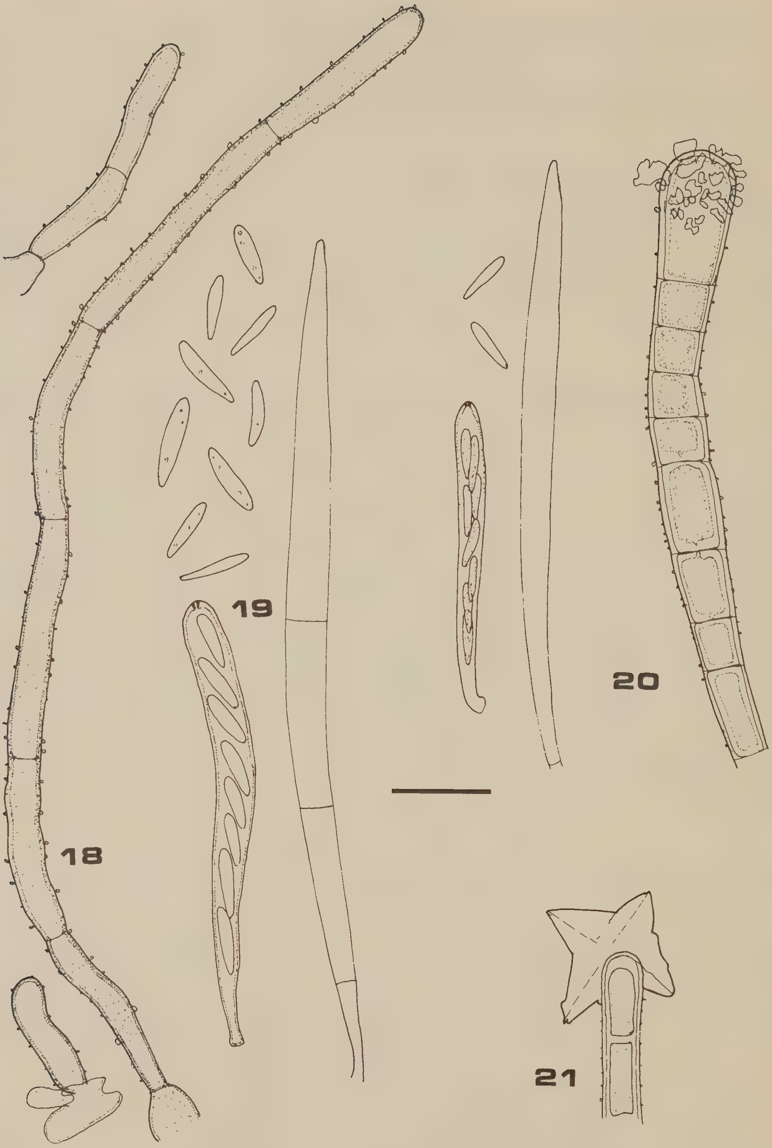
=*Trichopeziza subochracea* (Cooke & Peck) Sacc.,

Syll. Fung. 8:408. 1889.
=Lachnella subochracea (Cooke & Peck) Seaver, N. Amer. Cup-fungi (inoperculates) p. 251. 1951.
=Dasyscyphus subochraceus (Cooke & Peck) Thind & Singh, J. Indian Bot. Soc. 40: 304. 1961.

Type: U.S.A., NY, "Adirondack Mts." on dead stems of Rubus odoratus, Aug., C. H. Peck (holotype K, sent from Peck to Cooke 25 Aug 1871 as #93; isotype NYS without number; duplicate sent to NY in 1935; also in CUP-D). The isotype collection at NYS contains about 20 sections of cane and several hundred apothecia in good, mature condition.

Discussion: The type of this species was reexamined and illustrated by Dennis (1963) and was found to be, not Hyaloscyphaceous, but a typical Calycella as that genus was interpereted at that time. Spooner (pers. comm.) has pointed out that this probably belongs in the genus Bisporella, but no transfer will be made at this time. Reports from India appear to be erroneous. The collection on which the first Indian report and transfer of the species to Dasyscyphus was based is not conspecific with the type and has subsequently been described as a new species of Dasyscyphus, D. thindii Sharma, Bibl. Mycol. 91: 115. 1983. [=Lachnum thindii (Sharma) Sharma]. Only two authentic collections are kown, the second, aside from the type, being another Peck gathering from Lower Ausable, Adirondack Mts., Jul (NYS).

Lachnum sulphurellum (Peck) Raitv., Folia Crypt. Estonica 20: 2. 1986. Figs. 20,21,27.
Basionym: Peziza sulphurella Peck, Annual Rep. New York State Mus.30: 59. Sep 1878 [as Peziza (Dasyscypha) sulphurella] .
=Atractobolus sulphurellus (Peck) O. Kuntze, Rev. Gen. Plant. 3: 445. 1898.
=Incrucipulum sulphurellum (Peck) Baral & Krieglesteiner, Beih. z. Mykol. 6: 72. 1985.
=Peziza crucifera Phill., Gard. Chron. N. S. 10: 378. Sep 28, 1878.
=Dasyscypha crucifera (Phill.) Sacc. Syll. Fung. 8: 440. 1889.
=Atractobolus cruciferus (Phill.) O. Kuntze, Rev. Gen. Plant. 3: 445. 1898.
=Lachnum cruciferum (Phill.) Nannf., Trans. Brit.



Figs. 18-21. *Lachnum myricacea* (Holotype). 18. Long and short hairs. 19. Ascus, ascospores and paraphysis. *Lachnum sulphurellum* (Holotype). 20. Ascus, ascospores, paraphysis and hair. 21. crystal.

Mycol. Soc. 20: 194. 1936.

Apothecia up to 0.4 mm diam., scattered on the substrate, shallow cup-shaped, covered with hairs, with flat, concolorous disc when mature and moist, closing to deep cup-shaped with disc mostly obscured by infolding margin when dry, pale yellow throughout when fresh, becoming white with an orange ochraceous disc when dried, stipitate. Stipe equal to diam. of disc, concolorous, covered with crystal-capped hairs which may be seen with a good quality hand lens. **Ectal Excipulum** hyaline textura prismatica, of slightly thick-walled, inflated brick-shaped or cuboid cells up to 9 X 12 µm. Individual cells are more distict when viewed in squash mounts than in most Hyaloscyphaceae. **Hairs** up to 120 µm long, usually 50-80 X 4-7 µm, cylindrical or slightly tapered toward the base, sometimes with swollen apex, rigid, straight, thick-walled with thick septa forming comparatively short cells 5-10 µm long, covered with very fine granules throughout or occasionally almost smooth, often capped with conspicuous, regular, flattened, easily crushed tetrahedral crystals ca. 10 µm across, which do not dissolve quickly in 3% KOH. Thinner-walled, strongly granulate hairs lacking crystals are also present in most specimens. **Asci** 30-35 X 3-4 µm, cylindrical with a short tapered base without conspicuous croziers and a hemispherical apex with a small pore plug which turns dark blue in IKI without KOH pretreatment, 8-spored. **Spores** (6-)7-8(-8.5) X 1.2-1.8 (-2.0) µm, narrowly fusiform, slightly larger in the upper portion, straight, non-septate. **Paraphyses** 3.0-5.5 by up to 30 µm longer than the asci in the hymenium, definitely lanceolate with sharp tips.

Type: U.S.A., New York, Adirondack region, Essex Co., dead stems of Myrica gale. From here there is a small descrepancy in the exact locality. Pecks' notebook for 1876 gives the locality as "Lake Jimmy", but the only original specimen which is labeled as the type gives "Lake Sallie" (an apparent misspelling of Lake Sally) as the locality. This is a minor point since the two lakes are less than a mile apart in Essex county in the central Adirondacks. Both lakes were listed in his collecting intinerary only once, and that was for August of 1876. The type collection is now in two portions with the same label information. It was common practise for Peck to split his larger collections into "herbarium material" and "study material" and most of the collections were reassembled by subsequent curators. The two portions will be treated here as the same collection. The portion in the packet contains Pecks original label and about 20 small twig fragments. The other portion, now in a later box with a later label, contains 7 larger stem fragments. Both collections contain numerous apothecia, but most of them are past maturity and do not revive well in microscopic preparations. Another small portion is in the Durand herbarium CUP-D, and there is a record of another portion being sent to Phillips.

Host: Twigs of *Myrica gale* which retain their bark and leaves.

Range: Known from Canada, U.S.A., British Isles and Sweden. It is possibly throughout the range of its host.

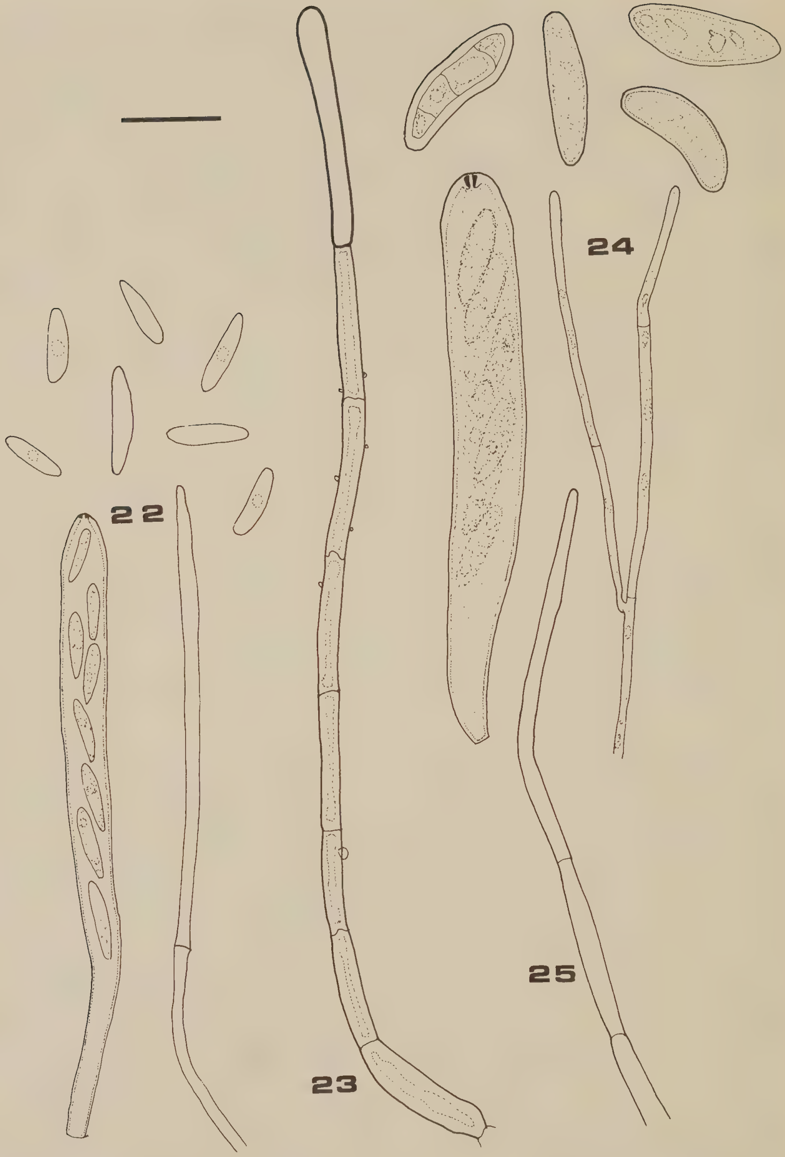
Specimens Examined: British Isles, North Wales, on *Myrica gale*, W.Phillips, (apparent isotype, NYS); U.S.A., NY, (see type); Warren Co., Bolton Landing, Skye Farm Camps, Sherman Pond, on *Myrica gale*, 25 Aug 1971, Haines 1829, S.J.Smith & G.Samuels (NYS); Warren Co., Pack Experimental Forest, on *Myrica gale*, 25 Sep 1971, Haines 1927, Peck Foray (NYS); Warren Co., Pack Experimental Forest, on *Myrica gale*, 6 Jul 1972 Haines 2288 & 2300 (NYS); Franklin Co., Lake Clear Girl Scout Camp, on *Myrica gale*, 15 Aug 1974 Haines 2720 & R.Fogel (NYS); Warren Co., Pack Experimental Forest, on *Myrica gale*, 22 Jun 1978, Haines 3317 (NYS); Hamilton Co., bog 1 mi S of Speculator, on *Myrica gale*, 2 Jul 1980, J.H. & Emily Haines 3490 (NYS); Warren Co., Pack Experimental Forest, on *Myrica gale*, 11 Sep 1982, Haines 3563 Peck Foray (NYS); Hamilton Co., town of Long Lake, Southern Raquette Lake, Silver Beach, on *Myrica gale*, 7 Sep 1986, Haines 3920 & 3934 Peck Foray (NYS); Franklin Co., near outlet of Stony Creek Pond, Corey's, on *Myrica gale*, 3 Jul 1988 Haines #4059 (NYS); same as preceeding but 18 Jul 1988 Haines #4070 (NYS); Essex Co., town of North Elba, W bank of Chubb River near the start of the Northville-Placid trail, on *Myrica gale*, 18 Jul 1988, Haines 4081 (NYS); Warren Co., Burnt Pond, elevation ca. 950 ft., on *Myrica gale*, 9 Jul 1971, S.J.Smith 46427, E.C.Ogden & P.Walker (NYS).

Discussion: This species is, so far, known only from *Myrica gale* and is immediately recognizeable by its short-celled, thick-walled hairs tipped with tetrahedral crystals of calcium oxalate. It has some features in common with *Lachnum bicolor*, and the genus *Incrucipulum* Baral is available for those who choose to recognize it as distinct from *Lachnum*.

The history of this taxon is confusing, and the puzzle of who published it first remains to this day. It was first collected by Peck, August 1876 and was included in his notebook and report for that year. The next mention of the species is another entry in his notebook when he included a specimen of "*Peziza sulphurella* Pk." in a package sent to William Phillips on January 23, 1877. A few months later in June 1878, Phillips collected the same species on the same substrate, *Myrica gale*, in North Wales but gave it a new name, *Peziza* (Dasyscypha) *crucifera* Phillips and sent a short note describing it as new to the Gardeners Chronicle, all while Peck's species was in the slow process of publication with his annual report. Peck's report was finally published sometime in September of 1878 (Petersen 1980), and Phillips note on September 28 of 1878. In all likelihood, Pecks *Peziza sulphurella* has priority and it will be treated that way here.

Dasyscyphella sulphuricolor (Peck), Haines, **comb. nov.**
Figs. 22,23.
Basionym: *Dasyscypha sulphuricolor* Peck, New York State Mus. Bull. 157: 25. 1912.
=*Dasyscyphella cinnamomea* Raitv. Eesti NSV Tead. Akad., Biol. 26: 31. 1977.

Apothecia up to 2.5 mm diam., scattered on substrate, shallow cup-shaped to salviform, short stipitate, covered with sulphur yellow hairs when fresh, becoming buff with dark adhering matter when dry, margins infolding when dry, but not so much as to cover the disc. Disc apricot-colored when dry. **Excipulum** *textura angularis* composed of thin-walled, inflated cells up to 10 X 25 µm. **Hairs** up to 125 µm long by 2.0-3.0 µm, of the "nivea" type, slightly enlarged, often refractive and smooth above, narrowed and coarsely granulate in the middle and wider, septate and fine granulate at the base, hyaline but exuding a faint vinaceous pigment in 3% KOH. **Asci** 55-75 X 4.5-5.5 µm, cylindrical, with slightly tapered base lacking conspicuous croziers and a hemispherical apex with a pore. **Spores** (8-) 9-11 (-12.5) X 2.0-2.8 µm, fusiform-ellipsoid, curved, occasionally 1-septate, often slightly thick-walled. **Paraphyses** definitely filiform with rounded tips, 1.5-2.5 µm diam., not superceeding the asci in length, occasionally branched.



Figs. 22-25. Dasyscyphella sulphuricolor (Holotype). 22. Ascus, ascospores and paraphysis. 23. Hair. Amicodisca viridicoma (Holotype). 24. Ascus, ascospores and paraphysis. 25. Hair.

Type: U.S.A., New York, Oneida Co., Remsen, on decaying wood of black ash, Fraxinus nigra Marsh., Aug. 1911, C. H. Peck (holotype NYS). The holotype collection consists of ca 20 carved off chips of wood, and more than 200 mature apothecia, many of which are dislodged and lying loose in the box.

Host: Fraxinus, and possibly other partially decayed hardwoods. In the specimens examined by the author, the wood is decorticated and decayed away in cavities with sound wood underneath.

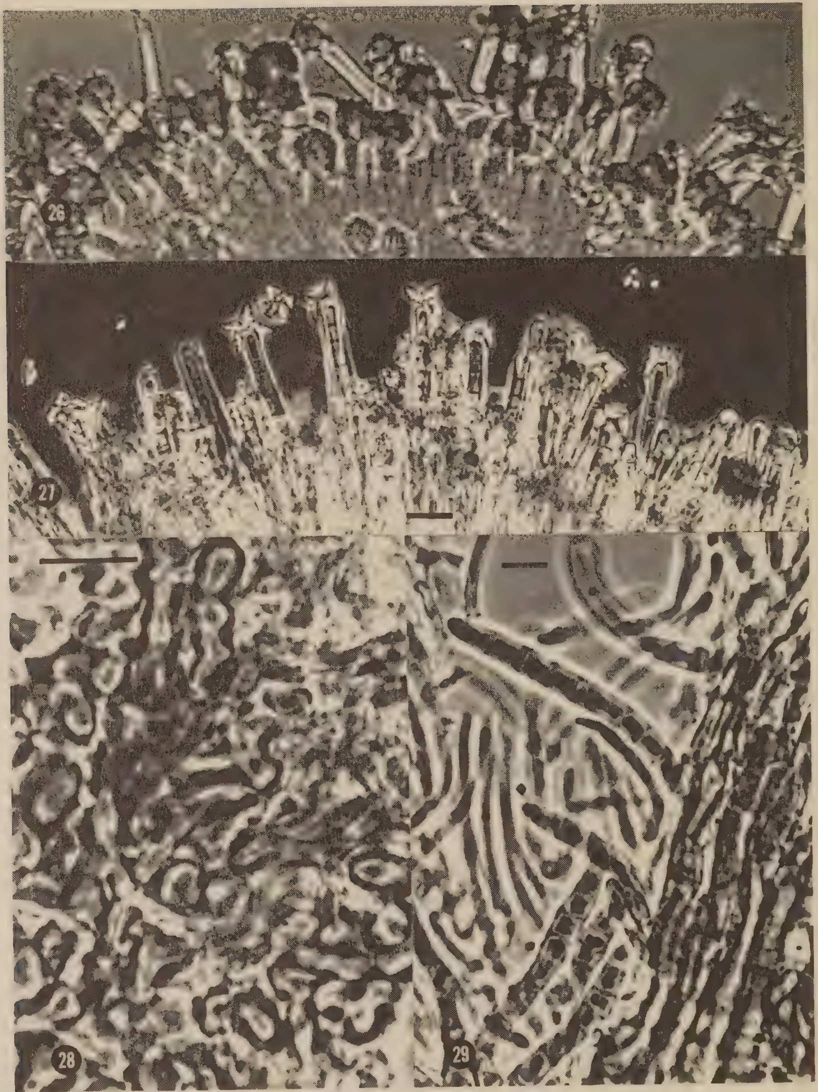
Range: So far, known only from New York and Pennsylvania.

Specimens Examined: U.S.A., New York, (see type); Pennsylvania, West Chester, E.H.J.& G. #390 (holotype of Dasyscyphella cinnamomea NY; isotype CUP-D).

Discussion: This large species of Dasyscyphella is distinguished by its yellow color when fresh which turns grey-buff with adhering dark resin particles when dry, comparatively large spores and asci and filiform paraphyses. Examination of the type of the recently described D. cinnamomea Raitv. has shown the two to be identical. It differs from D. dryina (Karst.) Raitv. in its shorter stipe, stouter cup and in having dark resin granules adhering to the hairs when dry, and from D. nivea in its larger spores and total lack of yellow-orange pigment when dry.

Lachnella tiliae (Peck) Donk apud Singer, Lilloa 22: 245. 1951.
Basionym: Peziza tiliae Peck, Annual Rep. New York State Mus. 24: 96. 1872.
=Trichopeziza tiliae (Peck) Sacc., Syll. Fung. 8: 428. 1889.
=Cyphella tiliae (Peck) Cooke, Grevillea 20: 9. 1891.

As M. C. Cooke pointed out, this fungus is not a discomycete as Peck thought, but a basidiomycete. Peck did not describe any microscopic details, but he compared the fungus to Peziza bicolor. It is fully described and illustrated by Reid (1963). It is, perhaps, ironic that Peck made the same mistake on the very same page of his annual report when he described a new genus and species,



Figs. 26-29. 26. Lachnum capitatum, holotype, apothecial margin with hairs tipped with irregular crystal masses. 27. Lachnum sulphurellum, JHH 4081, apothecial margin with hairs tipped with tetrahedral crystals. 28. Perrotia distincta, holotype, excipular surface. 29. Solenopezia solenia, holotype, excipular surface with hairs. Bar equals 10µm.

Nodularia balsamicola, with asci when his specimen was referable to the basidiomycete genus Aleurodiscus. The holotype of Peziza tiliae is at NYS and is labeled as being collected in Knowersville. Knowersville is a small town West of Albany, NY now known as Altamont and despite the fact that it is described as being in the Helderberg Mountains, it is at a relatively low elevation. There is a record of a duplicate collection being sent to M. C. Cooke as specimen #366 on 28 Jan 1875.

Cistella grevillei (Berk.) P. Raschle, Nova Hedwigia 30: 659. 1978.
Basionym: Peziza grevillei Berk., Engl. Flora 5(II): 198. 1837.
=Peziza urticina Peck, Annual Rep. New York State Mus. 32: 46. 1880.

Apothecia up to .4 mm diam., cup-shaped, becoming spherical with the disc completely obscured by the infolding margin when dry, narrowed to a small base, exterior of cup partially covered with hairs which appear as white meally patches, faint, vertical striations appear with shrinkage on some dried specimens, whitish when fresh, darkening to yellow-buff when dry. **Excipulum** distinct, thin-walled, hyaline textura angularis. **Hairs** up to 40 µm long by 3-7 µm, clavate, with enlarged apical cell, thin-walled, 1-3 septate, roughened with fine granulations on the apical cell only. **Asci** 45-50 X 4.5-5.5 µm, cylindrical with a short, tapered base often subtended by a crozier, and a slightly tapered apex with a minute but distinct pore, 8-spored. **Spores** 11.0- 12.5 X 2.0-2.5 µm, elongate-ellipsoid, non-septate, hyaline. **Paraphyses** almost cylindrical with a slightly lanceolate, blunt tip up to 2.0 µm wide and up to 10 µm longer than the asci in the hymenium.

Type: U.S.A., New York, Catskill Mountains, probably Ulster County as that is the only Catskill county mentioned in list of counties Peck visited in 1878, dead stems of nettle, Urtica canadensis [=Laportea canadensis (L.) Gaud. ex Freyc.], Jul 1878, C. H. Peck (NYS); Isotype at CUP-D. There is a record of a portion being sent to NY in 1935. The holotype collection consists of ca 30 pcs of herbaceous stem. In total there are several hundreds of apothecia.

Host: Usually found on Umbelliferae and Urticaceae, known from Heracleum; Urtica; Laportea; also Adenostyles.

Range: Common in Europe, Western U.S.A., also reported from India, Middle Asia and Canada, rare in the Eastern U.S.A.

Specimens Examined: U.S.A., New York, (see type); Washington, Gray's Harbor Co., Gray's Harbor City, on *Heracleum lanatum* 12 June 1966 JHH 395 (NYS); King Co., Seattle, Denny Park, on *Urtica lyallii* 17 May 1967 JHH 476.

Discussion: Peck's *P. urticina* is a later synonym for Berkeley's *P. grevillei*, a species which is apparently rare in the Eastern U.S.A. Peck's specimen is the only one I have seen from that region. It is distinquished from other discomycetes on herbaceous stems by its watery, light grey appearance when fresh and its short, granulate hairs. The generic disposition of this species has been difficult. It has most of the characters of *Lachnum*, but in a reduced form. Its stipe is reduced to a narrow point of attachment, its paraphyses are nearly cylindrical but retain a blunt lanceolate tip and its hairs are short, clavate and rough only in the apical cell. It fits in *Cistella* when that genus is accepted in the broad sense, but if *Clavidisculum* is accepted as distinct it can be placed there.

Amicodisca viridicoma (Peck) Haines **comb. nov.** Figs. 24,25.

Basionym: *Peziza viridicoma* Peck, Annual Rep. New York State Mus. 31: 46. 1879. [As *Peziza* (Dasyscyphae) *viridicoma*] =*Lachnella viridicoma* (Peck) Seaver, North American cup-fungi, p. 267. 1951.

=*Trichopeziza viridicoma* (Peck) Sacc., Syll. fung. 8: 414. 1889.

Apothecia up to .4 mm in diam., scattered to gregarious on undifferentiated, decorticated wood surfaces, shallow to deep cup-shaped, sessile, externally black, covered, with greenish-yellow hairs which become olive-brown when dried, releasing faint olive yellow pigment in KOH. **Excipulum** of hyaline, yellowish or slightly olivaceous *textura prismatica* to *angularis*, composed of thin-walled cells up to 12 μm in the greatest dimension. **Hairs** up to 100 μm long by 2.0-3.5 μm in diam at the base tapering to about 1 μm at the tip, straight, thin-walled, hyaline or yellowish, septate, smooth or with a few loosely attached granules, **Asci** 55-65(-75) X 7.5-11(-14)µm, clavate-cylindrical with a narrow base lacking croziers and a conical apex containing a large, conspicuous J+ pore ca. 1.5 µm in diam., 8-spored. **Spores** 12-16(-17.5) X 3-5 µm, clavate-ellipsoid, curved, occasionally 1-3-septate, usually with two large refractive inclusions, turning greenish brown with age after release from the ascus. **Paraphyses** filiform, 1.0-1.5 µm in diam., not superceeding the asci in length, occasionally branched, hyaline, very thin-walled, flexuous.

Type: U.S.A., New York, Rensselaer Co., Town of Sandlake, on unidentified, partially decayed wood, August (no year recorded), C.H.Peck (NYS) holotype; Portion of type at CUP-D. The holotype consists of 3 pcs of decayed wood attached to small portions of herbarium sheet. Only the largest of the three now has any obvious fungus material. It has about 50 apothecia.

Hosts: On partially decayed wood of Betula, Alnus rugosa and unidentified hardwoods.

Range: Known from the Northeastern U.S. and Japan. It is probably much more widespread but it has not been recognized or collected from elsewhere.

Specimens examined: U.S.A., New York (see type); Rensselaer Co., Grafton State Park, on Betula, 12 Jun 1980, Haines #3438 (NYS); Hamilton Co., Adirondack region, town of Long Lake, Raquette Lake, Camp Pine Knot, on Alnus rugosa, 28 Jul 1987, Haines #3967, T.Baroni & mycology class (NYS); JAPAN, Honshu, Gumma Pref., along the North shore of Lake Marunima, on decorticated log, R. P. Korf, Fungi of Japan, 7 Oct 1957 (CUP).

Discussion: This pretty little discomycete is distinquished by its yellow-green hairs, dark exciple, large asci and spores and narrow paraphyses. It has rarely been collected and has apparently not been redescribed since its original publication in 1877. Until the recent publication of Amicodisca by Svrcek (1987) there seemed to be no genus in which this species fitted comfortably.

Acknowledgments

The author wishes to give heartfelt thanks to Dr. Brian Spooner, Dr. Ain Raitviir and Prof. Richard P. Korf for their careful and thoughtful reviews and comments, and each of whom prevented me from making foolish errors, and to Dr. Gordon C. Tucker for his technical assistance with the preparation of the manuscript. The author also wishes to thank the curators of CUP, NY and BR for the loan of specimens that made the comparative part of this study possible.

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A NEW TRICHOCLADIUM ISOLATED FROM SUBMERGED WOOD TEST BLOCKS IN A FRESHWATER STREAM

by

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Summary: Trichocladium angelicum, a new dematiaceous hyphomycetes, is described in pure culture from submerged wood test blocks in a freshwater stream. Differences between T. angelicum and T. achrasporum are discussed.

Trichocladium angelicum sp. nov. (Figs. 1-2)

Coloniae supra agarum maltosum (1%) atrae, compactae, lentissime crescentes, restrictae; mycelium aerium sparsum, gossypinum, griseum; chlamydosporae brunneae, 7-12 μm in diam., catenatae vel irregulariter aggregatae. **Sporulatio** atypica in culturis agarosis, sed typica in culturis subaquaticis, post 5-6 dies, sub vel summa aqua. **Conidiophora** ex hyphis vetustis vel novis ecrescentia, subhyalina usque ad griseo-brunnea, micro- usque ad semimacronematosa et mononematosa, apicalia vel lateralia, usque ad 75 x 3.5-5.5 μm. **Cellulae conidiogenae** apicales vel laterales, mono- vel polyblasticae, 4-17 x 2.5-5.5 μm. **Conidia** solitaria, raro bina, acrogena, raro pleurogena, crassitunicata, glabra; cellula basalis hyalina, obconico-truncata, 3-12 x 2.5-4.5 μm; cellula ceterae (3-5) inflatae, subhyalinae et vacuolatae, typice auctae ad apicem versus; cellula apicalis globosa vel ellipsoidea; conidia (cum cellula basali) 25-47 x 7.5-12 μm. Disjunctio rhexolytica. Germinatio in agaro maltoso cum antibioticis tardissima, filamentum germinale e base conidii ecrescens, sed saepe mox periit.

Etym: named in grateful honour of Dr. Mª Angeles Puig, of this University.

Colony (1% MA) black, compact, growth restricted and very slow (0.8 cm diam./3 months), aerial mycelium sparse, cottony, greyish, chlamydospores brown, 7-12 μm diam., catenate or in irregular groups. **Sporulation** atypical on agar, but abundant and typical when colony pieces are submerged in sterile distilled standing water for 5-6 days, underwater and at the surface. **Conidiophores** directly on old hyphae on the cut surfaces or on new fast-growing hyphae, subhyaline to greyish-brown, micro- to semimacronematous and then mononematous, apical or lateral, up to 75 x 3.5-5.5

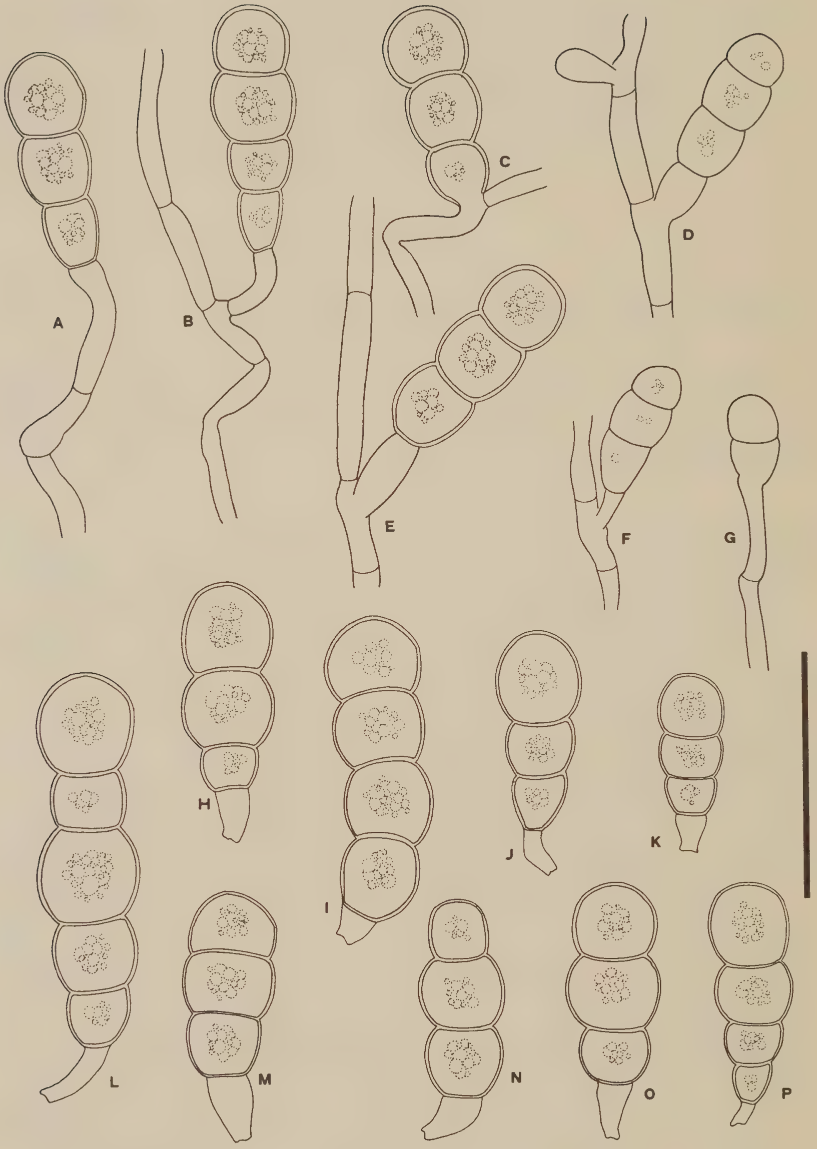
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Fig. 1.- Trichocladium angelicum in pure culture (holotype). A-G, conidiophores. H-P, detached conidia. Bar = 30 µm.

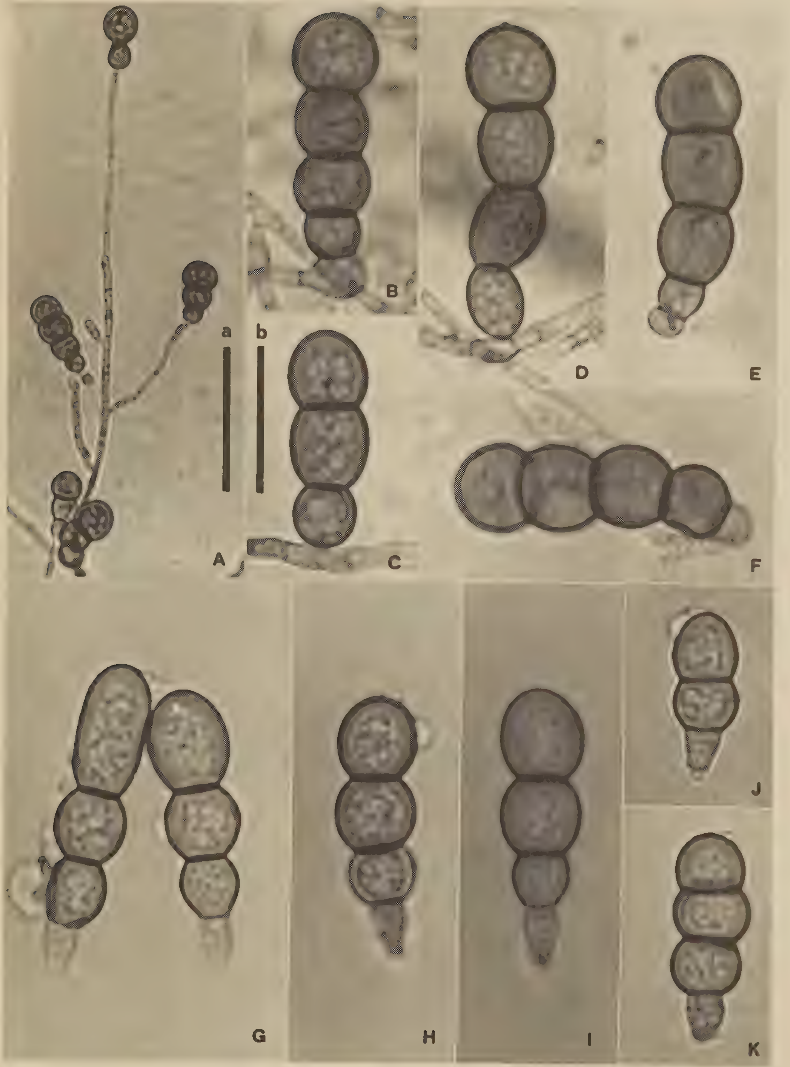

Fig. 2.- Trichocladium angelicum. A-F, conidiophores and detached conidia from pure culture (holotype). G-K, detached conidia on naturally colonized wood. (Lactofuchsin mounts). A, according to scale "a" = 50 µm. Rest, according to scale "b" = 20 µm.

µm. **Conidiogenous cells** apical or lateral, mono- or polyblastic, 4–17 x 2.5–5.5 µm. **Conidia** solitary, rarely paired, acrogenous, rarely pleurogenous, walls thick and smooth, basal cell (remains of separating cell) hyaline, obconico-truncate, 3–12 x 2.5–4.5 µm; the remaining 3–5 cells swollen, subhyaline and highly vacuolate, typically larger towards the apex, apical cell regularly globose to ellipsoid; conidia (including basal cell) 25–47 x 7.5–12 µm. **Secession** rhexolytic. **Germination** after failing or on malt-agar with antibiotics very slow, germ tube basal, growing through scar, reaching 75 µm in 5 days, then often interrupting growth.

Type: monoconidial isolate from submerged *Populus* wood for six months in the River Vinalopó (Bañeres, *Alicante, Spain*), A. Roldán, March 1988 (MA FUNGI 21517) holotype ex MUB: AR 9875 isotype.

Although repeatedly isolated, only one culture was established, due to poor conidial germination. Both conidiogenesis and conidial morphology of this fungus fit those of *Trichocladium* Harz. The nearest species is *Trichocladium achrasporum* (Meyers & Moore) Dixon in Shearer & Crane (1971), a marine fungus first described as *Culcitalna achraspora* Meyers & Moore (1960), which produces sporodochia on wood. Kohlmeyer & Kohlmeyer (1979) accept its reallocation in *Trichocladium* because the degree of conidiophore aggregation is not quite that of a sporodochium. They describe the conidia as obpyriform and strongly pigmented. Ellis (1976) retains *Culcitalna* Meyers & Moore and illustrates conidia similar to ours, but much darker. Its teleomorph is the marine ascomycete *Halosphaeria mediosetigera* Cribb & Cribb (Shearer & Crane, 1977).

Trichocladium angelicum differs from *T. achrasporum* in having longer conidia (which are pyriform in the latter), with strong septal constrictions and lacking dark pigmentation. Furthermore, the two fungi are known from very different habitats, the type locality of *T. angelicum* being a hard water mountain stream (800 msm.).

We should like to thank Dr. E. Descals for English translation and Dr. L. Marvanová for kindly providing the latin diagnosis. We are also indebted to Dr. P.M. Kirk for his comments on the identity of *T. angelicum*.

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MYCOTAXON

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SCUTELLOSPORA SCUTATA SP. NOV., A NEWLY DESCRIBED ENDOMYCORRHIZAL FUNGUS FROM BRAZIL

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SUMMARY

A new species in the genus *Scutellospora* is described and illustrated. The fungus was isolated from Cerradão xeromorphic forest in Brazil, and has formed mycorrhizas with arbuscules and hyphal coils, but without vesicles, in pot culture with corn, sorghum, *Cajanus,* and *Brachiaria* .

INTRODUCTION

Investigations into the Endogonaceae of the Cerrado Region of Brazil have been carried out in order to isolate mycorrhizal fungi that may be useful in tropical agricultural systems by increasing nutrient uptake of crop plants (Diederichs, unpublished). Among spores found in soil samples collected from the root zone of wild pineapple, *Ananus comosus* (L.) Merr., was an undescribed member of the genus *Scutellospora,* which was successfully established in pot culture with *Zea mays* L., *Cajanus cajan* (L.) Millsp., *Sorghum bicolor* (L.) Moench., and *Brachiaria decumbens* (Stapf.). The species has unusually large spores and a prominent germination shield. Because of the latter feature, it is given the name *Scutellospora scutata* sp. nov. Descriptions of color (Anon. 1969) are from fresh spores immersed in water and viewed with tungsten lighting under a dissecting microscope at up to 50X magnification. Other details are described from spores mounted under a compound microscope at magnifications of up to 2000X with bright field illumination or Nomarski differential interference contrast. Wall structure descriptions follow the standardizations of Walker (1983, 1986) and Morton (1986).

SCUTELLOSPORA SCUTATA Walker et Diederichs sp. nov. (Figures 1 & 2)

Sporae in solo singillatim lateraliter vel raro terminaliter in cellula brunnea bulbiforme suspensoriforme efformatae, globosae, subglobosae vel raro ovoideae, 350-667 x 350-713 µm, juventute hyalinae at que diaphanae, postea opaceae, sordidae albidae vel olivaceo-bubalinae.

Tunica sporarum sex in turmis duabus (A et B) vel tribus (A, B et C). Turma A tunica 1 externa, hyalina, laevi, 0.2-0.8 μm crassa, ad tunicam 2 interiorum sordide albidam vel olivaceo-bubalinam, 3.4-16.7 μm crassam arcte adherenti. Ubi tunicae sporarum in turmis duabus, turma B tunicis quator (3-6); tunica 3 coriacea, 2.3-8.4 μm crassa, cum tunica 4 tenui, membranacea, 0.2-0.8 μm crassa laxe consociata; tunica 5 coriacea, 2.2-8.2 μm crassa, ad tunicam 6 amorpham, 0.2-0.5 μm crassam arcte adhaerens. Ubi tunicae sporarum in turmis tribus, turma B tunicis 3 (coriacea) et 4 (membranacea), turma C tunicis 5 (coriacea) et 6 (amorpha).

Scutum germinationis complexum, ovale vel cordatum, castaneum, multilobatum, 240-323 x 208-302 μm. Cellula suspensoriformis 92-125 x 47-100 μm. Cellulae auxiliares porphyriae, laeves vel nodosae, 17-55 x 15-45 μm, 4-25 arcte fasciculatae in hypha tortuosa, brunnea, 5-12.5 μm crassa.

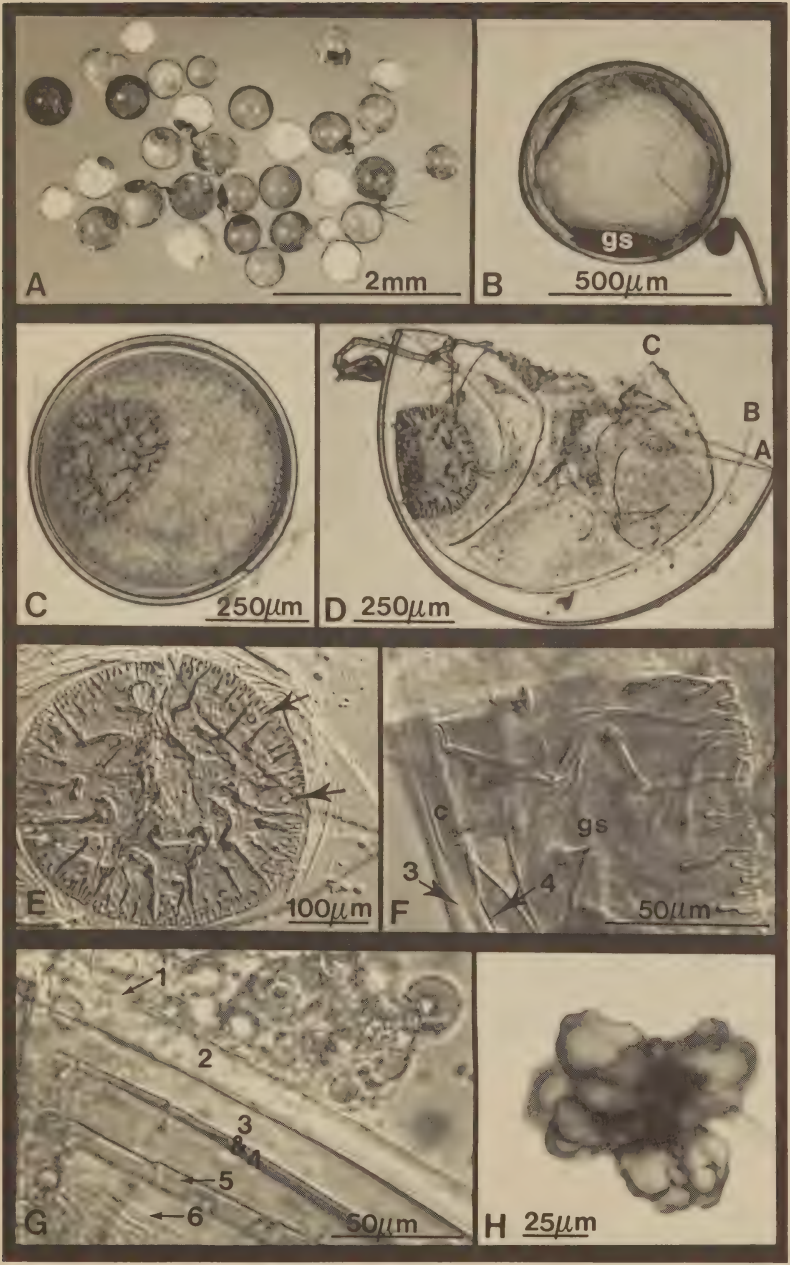
SPORES borne singly in the soil laterally (rarely subterminally) on a brown pyriform suspensor-like cell, globose to subglobose (rarely ovoid), 350-667 x 350-713 μm [mean (n = 53) 532 x 530 μm,] hyaline and transparent with vacuolar contents when young, later becoming opaque, dirty white to olivaceous buff.

Spore wall structure (Fig. 2) of six walls (1-6) in two or three groups (A & B or A, B & C). *Group A* with a hyaline, smooth, outermost unit wall (1), 0.2-0.8 μm thick, tightly adherent to a dirty-white to olivaceous buff laminated wall (2), 3.4-16.7 μm thick. When in two groups, *Group B* consisting of four walls (3-6). Wall 3 coriaceous, 2.3-8.4 μm thick, loosely associated with a thin membranous wall (4), 0.2-0.8 μm thick. Wall 5, coriaceous, 2.2-8.2 μm thick tightly adherent to an amorphous wall (6), 0.2-0.5 μm thick when not heavily crushed in an acidic mountant. When in three groups, *Group B* of the loosely associated walls 3 (coriaceous) and 4 (membranous) and *Group C* of the tightly adherent walls 5 (coriaceous) and 6 (amorphous).

Germination shield complex, circular to oval or heart-shaped, chestnut-brown, multi-lobed, 240-323 x 208-302 μm, present in wall Group B of almost all mature spores. Germination shield in lateral view appearing to form compartments between wall groups.

Suspensor-like cell (92-125 x 47-100) μm) produced terminally on an often recurved, sparsely septate, brown subtending hypha up to 400 μm long; wall of suspensor-like cell 1-5 μm thick distally, thickening to 3-12 μm near the spore base; bearing one or more stout, peg-like hyphal protrusions 2.5-17.5 μm long and 2.5-15 μm broad.

Figure 1 *Scutellospora scutata*. A. Intact spores at low magnification. The conspicuous germination shields are evident on most specimens. B. An intact spore showing germination shields (gs) in side view. The spore is attached laterally to the suspensor-like cell in this specimen. C. In this specimen, which has lost its suspensor-like cell, the germination shield can be seen at the left. D. The three wall groups (A, B and C) can be distinguished in this crushed spore. E. Plan view of the germination shield on wall 6, illustrating the complex infolding at the edges. Several germ tube initials can be seen, two of which are arrowed. F. Details of a germination shield (gs) showing walls 4, 5 and 6 (numbered). The appearance in lateral view where the shield curves around the perimeter of the spore gives the impression of compartmentalization (Hall 1977). G. Detail of the six walls revealed by crushing the spores. Walls 3 and 4 are tightly adherent and cannot be distinguished individually at this magnification. H. A cluster of the auxiliary cells produced by this fungus.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2mm
B
gs
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6
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H
25µm

Auxiliary cells formed in the soil, red-brown, 17-55 x 15-45 μm, borne in tight clusters of 4-25 on coiled, brown hyphae 5-12.5 μm wide; smooth to knobby. Forming endogonaceous endomycorrhizae with arbuscules.

ETYMOLOGY: Latin, *Scutata*, armed with a shield. Referring to the prominent brown germination shield present on spores in this species.

DISTRIBUTION AND HABITAT: known from the root zone of *Ananus comosus* in the Ecological Area of the Cerradão Forest, Centro de Pesquisa Agropecuaria dos Cerrados (CPAC), Brasilia DF, Brazil. The soil type covering about 11 per cent of the Cerrado ecosystem is a dark red latosol (Haplustox) (Goedert & Lobato 1980). The vegetation of the Cerrado ecosystem can be defined as subhumid wooded savanna, although there is large variation from pure grassland to closed tree canopy (Eiten 1972). The latter is called 'Cerradão' in Brazil.

The vegetation is closely related to soil characteristics, for example some native tree species are able to grow despite the accumulation of large amounts of aluminum in their leaves (Haridasan 1982). The topsoil is up to 20 cm deep, with pH (KCl) 4 (pH in water, 4.5), organic content 1.8-2.5 per cent, extractable P 1.0 mg kg^{-1}, and exchangeable Al, Ca, Mg, and K of 1.45, 0.53, 0.15, and 0.10 mg kg^{-1}, respectively. The soil has a very high Al saturation of 67 per cent, a free $Fe_2 0_3$ content of 9.6 per cent, and a clay content (<2 μm) of 60 per cent.

Scutellospora scutata is associated in the field with *Gigaspora gigantea* (Nicol. & Gerd.) Gerd. & Trappe, *S. verrucosa* (Koske & Walker) Walker & Sanders, *Entrophospora* spp., *Glomus* spp. and *Acaulospora* spp.

MYCORRHIZAL ASSOCIATIONS: the species has formed arbuscular mycorrhizae with *Z. mays, S. bicolor, C. cajan*, and *B. decumbens* in pot culture. It is found in the field with endogonaceously endomycorrhizal *A. comosus* and associated tropical vegetation.

COLLECTIONS EXAMINED: HOLOTYPE: BRAZIL - Centro de Pesquisa Agropecuaria dos Cerrados. Walker 997 (OSC, isotypes FH, K). From pot culture with *Zea mays*. Field collections of spores from the Cerrado Region have also been examined.

DISCUSSION

This species can be distinguished from all other members of the genus by the combination of the large size, color, smooth outer wall, and prominent brown germination shields of its spores. The only other described species with spores of similar size and possessing a similar germination shield, is *S. nigra* (Redhead) Walker & Sanders, a species with dark brown to black spores which have an outer wall pitted by rounded pores (Nicolson & Schenck 1979, Koske, Miller & Walker 1983).

The suspensor-like cell of this species readily becomes detached during spore extraction to leave a sessile spore. Under such circumstances, the spores could be misidentified as belonging to a species of *Acaulospora*. Great care should therefore be taken when examining collections of this or similar species in the genera *Gigaspora* or *Scutellospora*.

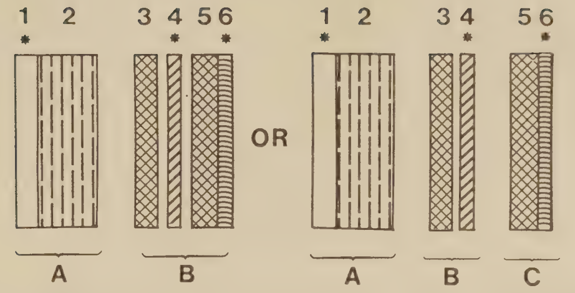

Figure 2. Murograph (after Walker 1983) of *Scutellospora scutata*. Unit walls are unshaded. Shading is by vertical alternating dashed lines for laminated walls, 45⁰ hatching in one direction for the membranous wall, 45⁰ hatching in both directions for the coriaceous walls. The amorphous wall is indicated by segments of parallel circles. Walls marked with an asterisk can be difficult to see.

ACKNOWLEDGMENTS

We wish to thank Dr. J. M. Trappe, Oregon State University, and Dr. J. B. Morton, West Virginia University, for reviewing the manuscript. Dr Trappe kindly prepared the Latin diagnosis. Thanks are also due to S. Swan (Forestry Commission) for typing the manuscript and L. Hanson (Forestry Commission) for typesetting the camera-ready copy.

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AMANITA RISTICHII: A NEW SPECIES FROM NEW ENGLAND WITH BASIDIA DOMINANTLY 2-SPORED

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Summary

Amanita ristichii is described as new from southern Maine and New Hampshire. Worldwide, this is the fourth taxon of section *Vaginatae* to be described as having dominantly bisterigmate basidia. Two other species (*A. pachysperma* Atkinson and *A. virginiana* (Murrill) Murrill) were also described from the eastern United States. *Amanita submembranacea* var. *bispora* Reid was described from the United Kingdom.

Amanita ristichii Tulloss sp. nov. Holotypus: Maine, Oxford Co., Oxford, T. Herman 7-15-85-SSR1 (NY).[1]

Etymology: Named in honor of Dr. Samuel S. Ristich, Cumberland Center, Maine—entomologist, mycologist, lover of nature, and enthusiastic teacher.

Pileus albus, impolitus, 25 - 64 *mm in mensura diametrica; margine striata, nonappendiculata; materies volvica absentes. Lamellae condensae, in massa albae vel roseae; lamellulae abundantes. Stipes* 37 - 89 × 3 - 9 *mm, albus; annulus superus vel subsuperus, tenuis, albus, interdum evanescens; volva membranacea, alba,* 12 - 25 *alta, interdum limbis acutis. Dimidium vel duo trientes basidiarum bisterigmaticarum; fibulae praesentes. Sporae:* (9.2-) 10.2 - 14.2 (-17.0) × (6.6-) 7.0 - 9.0 (-12.8) *µm, subellipsoideae vel ellipsoideae vel elongatae, nonamyloideae.*

Belonging to section *Vaginatae*, *Amanita ristichii* (Fig. 1) is a rather small, delicate, white mushroom with a slender stipe exhibiting a superior to subsuperior annulus. The pileus usually has no remnants of the universal veil upon it and has a striate, nonappendiculate margin. The stipe base is contained by a saccate, persistent, membranous universal veil which is separated into several lobes. The lamellae are usually quite notably pinkish or pale orangish, although in one of six specimens

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[1]
FH - Farlow Library and Herbarium, Harvard University, Cambridge, Massachusetts, U.S.A.
NY - Herbarium of The New York Botanical Garden, Bronx, U.S.A.

All collections with no herbarium location cited are in the author's private herbarium. The author's collection numbers are composed of three numbers (month, day, year) and a string of characters which serve to distinguish fungi collected on a given day.

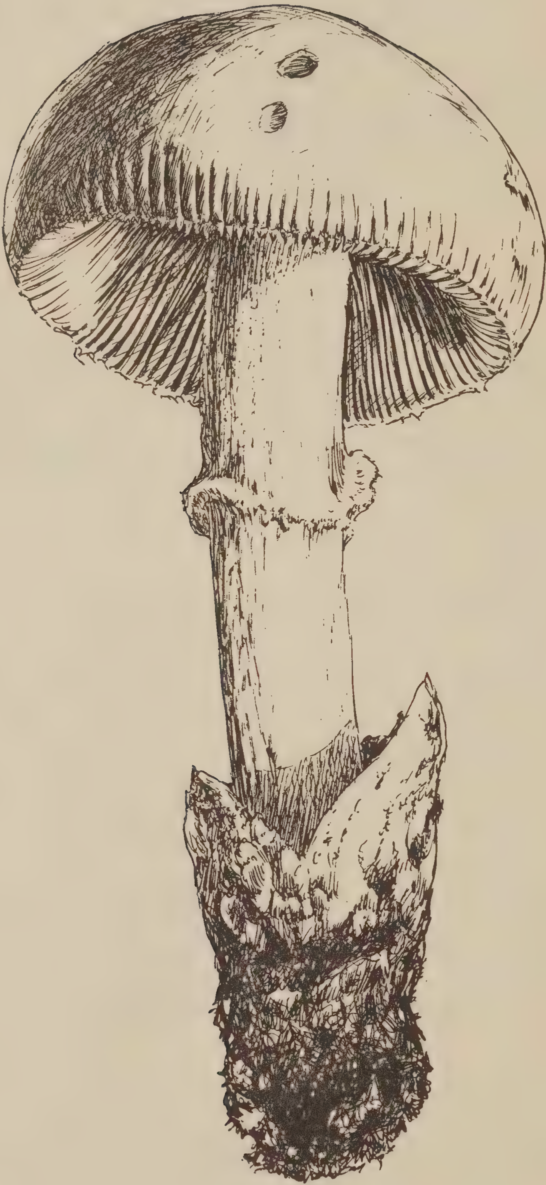

Fig. 1 *Amanita ristichii*. S. S. Ristich 7-11-84-SSR1 [×3].

examined, they were whitish. The microscopic characters that are particularly notable are the dominantly bisterigmate basidia and the rather large spores. At present, the taxon is known only from the southern parts of the states of Maine and New Hampshire, U.S.A.

PILEUS: 25 - 64 mm diam, hemispheric at first, becoming convex then planoconvex, sometimes with slight umbo, white, surface dull to slightly shiny, subviscid; margin striate (.2R - .3R), nonappendiculate; context whitish, 3± mm thick at stipe; lacking remnants of universal veil. LAMELLAE: close, about 3 mm or more broad, free to narrowly adnate, pinkish or (occasionally) whitish in mass, drying pinkish to pale orange (5A3[2] or 5YR 8/4[3]), occasionally anastomosing; lamellulae plentiful, subtruncate. STIPE: 37 - 89 × 3 - 9 mm, narrowing upwards, white, browning from handling, longitudinally striate, pulverulent above annulus, somewhat fibrillose below; context whitish, hollow with some cottony stuffing in 1 - 2 mm diam central cylinder; partial veil superior to subsuperior, white, delicate, finely striate above, sometimes disappearing or, if not, becoming appressed to stipe and browning at margin in age; universal veil membranous, persistent, saccate, breaking into several, sometimes pointed limbs about 1 mm thick, white to whitish, flaring in upper one-half to two-thirds or collapsed against the stipe, with tallest limb reaching 12 - 25 mm from stipe base; limbus internus positioned in upper third of interior surface of limb. Odor and taste not recorded.

PILEIPELLIS: 50 - 60 μm thick, composed of undifferentiated, filamentous hyphae and occasional oleiferous hyphae (sometimes in fascicles) randomly to subradially arranged, interweaving, gelatinizing throughout, but especially strongly in upper 10 μm; penetrated in lower portion by upturned tips of hyphae (filamentous or inflated) from pileus trama. PILEUS CONTEXT: a tangle of interwoven, branching, undifferentiated, filamentous hyphae <1 - 10.8 μm diam; slightly inflated hyphae to 19.6 μm diam; occasional oleiferous hyphae 1.7 - 4.5 μm diam; inflated cells to 135 × 45.5 μm, elongate clavate to bacilliform, somewhat difficult to reinflate. LAMELLA TRAMA: bilateral; branching undifferentiated filamentous hyphae 1.5 - 5.6 μm diam; somewhat inflated hyphae to 14.7 μm diam, with occasional, conspicuous clamps; inflated cells to 115 × 26 μm in chains; branching, oleiferous hyphae present 2.5 - 13.3 μm diam. SUBHYMENIUM: small cellular, subglobose to pyriform elements in short chains clustered at the end of the broadest diam hyphae which arise in the central stratum. BASIDIA: 42.5 - 60 × 8.5 - 12.5 μm, clavate to narrowly clavate, about half to two-thirds 2-spored, also 1-, 3-, and 4-spored, a number aborted or stunted (measurements of such not included in dimensions cited), thin-walled, apparently rapidly collapsing after release of spores; some basidioles branching; sterigmata to 3.5 μm long; clamps frequent. UNIVERSAL VEIL: throughout dominated by sublongitudinally oriented hyphae; outer surface consisting of interwoven to sublongitudinally arranged branching undifferentiated filamentous hyphae 1.7 - 5.6 μm diam, gelatinizing; inner surface composed of longitudinally oriented hyphae to 14 μm diam in a rather easily separable layer, less than five hyphal diams thick, somewhat gelatinizing; inflated cells confined to interior, terminal, broadly ellipsoid to cylindrical, up to 77 × 63 µm; oleiferous hyphae throughout 4.9 - 7.7 µm diam; tissues densest on inner and outer surfaces, else rather uniform in cross-sectional mount; in some specimens, all tissues somewhat difficult to reinflate except oleiferous hyphae. STIPE CONTEXT: acrophysalidic; branching, filamentous, undifferentiated hyphae, 1.0 - 4.2 µm diam; acrophysalides narrow elongate to 400 × 42 µm; oleiferous hyphae present 3.5 - 8.4 µm diam. PARTIAL VEIL: dominated by branching undifferentiated filamentous hyphae 1.4 - 7.7 µm diam, partially gelatinizing and difficult to reinflate; branching oleiferous hyphae 2.1 - 5.9 µm diam, densely tangled locally; inflated cells difficult to reinflate, apparently subglobose to broadly ellipsoid to ovoid to elongate to clavate, up to 81 × 49 µm. All tissues pale yellow in NH_4OH.

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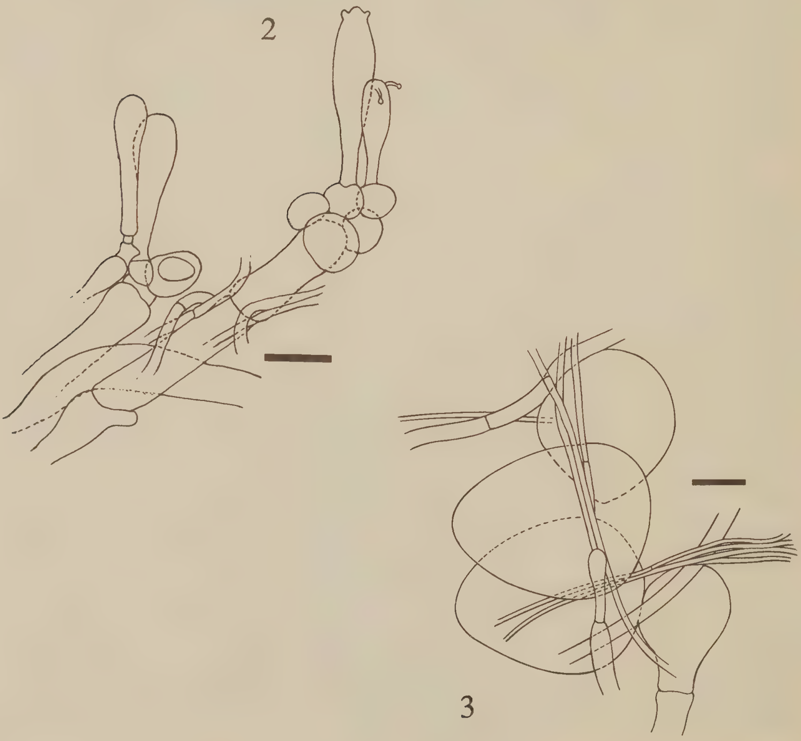
[2] This color code is from Kornerup & Wanscher (1978).

[3] This color code is from Munsell Color (1975).



Figs. 2-3 *Amanita ristichii*. 2. Portion of hymenium and subhymenium of holotype. 3. Internal layer of universal veil from stipe base of holotype. The bars in Figs. 2 & 3 represent 20 µm.

BASIDIOSPORES: [165 measured from 6 specimens] (9.2-) 10.2 - 14.2 (-17.0) × (6.6-) 7.0 - 9.0 (-12.8) µm, (average length per specimen = 11.5 - 12.4 µm; average length (overall) = 12.1 µm; average breadth per specimen = 7.8 - 8.5 µm; average breadth (overall) = 8.1 µm; Q = (1.22-) 1.33 - 1.70 (-1.84); average Q per specimen = 1.42 - 1.57; average Q (overall) = 1.50), inamyloid, thin-walled, hyaline, broadly ellipsoid to ellipsoid to elongate, occasionally expanded at or near one end; contents guttulate; apiculus sublateral, cylindric, 1 µm diam; white in deposit.

Habitat and distribution: Known only from southern Maine and New Hampshire. Found in July in sandy soil, solitary. In Maine, collections were made under *Tsuga canadensis* (L.) Carr. and *Acer rubrum* L. in the flood plain of a river or under *T. canadensis* and *Pinus strobus* L. as dominant trees in mixed woods. The New Hampshire collection was made under *Pinus sp.*

Collections examined: **UNITED STATES OF AMERICA**, MAINE, Androscoggin County, Sabbatus, S. S. Ristich 7-23-84-SSRA; Cumberland County, Windham, flood plain of Pleasant River, S. S. Ristich 7-11-84-SSR1, 7-13-88-SSRA, 7-13-88-SSRB, 7-30-88-SSR1; Oxford County, Oxford, T. Herman 7-15-85-SSR1 (holotype, NY); NEW HAMPSHIRE, Carroll Co., Chocorua, 28.vii.1906 L. C. C. Krieger Kr. 224 (FH).

DISCUSSION

After examination of the literature regarding 113 taxa belonging to *Amanita* section *Vaginatae*, I have found only one reference to a taxon described from outside of North America having basidia dominantly bisterigmate. Worldwide, I found a total of 56 species described in the literature as having 4-spored basidia; 3 (three) are described as having dominantly 2-spored basidia—*A. pachysperma* Atkinson (1918) and *A. virginiana* (Murrill) Murrill (1914) in North America and *A. submembranacea* var. *bispora* Reid (1987) from the United Kingdom.

C. Bas, Rijksherbarium, Leiden, The Netherlands, has observed (personal communication) that the presence of some bisterigmate basidia is not uncommon in many taxa of *Amanita*. In a number of taxa, it is not uncommon to find such basidia in specimens in which sporulation is just beginning. Dominance of bisterigmate basidia in mature basidiocarps is a character likely to be of taxonomic significance in sorting out section *Vaginatae*. Both of the previously described North American species with bisterigmate basidia are apparently rarely collected (Jenkins, 1986).

Described from sandy ground in woods, Watauga County, North Carolina, *A. pachysperma* is similar to *A. ristichii* in habit and in spore size and shape. Jenkins (1982) studied the type of *A. pachysperma*. Jenkins (1986) reports average Q of *A. pachysperma* = 1.45. It is described as being the color of ''*Amanita cinerea* Bres.'' (''*livido-grigiastro traente al cenerino*'' (Bresadola, 1881: 75)); and it differs markedly from *A. ristichii* in microscopic characters. For example, the acrophysalides of the stipe tissue of *A. pachysperma* are half the length of those of *A. ristichii*; also, the former has a ramose subhymenium and smaller basidia which lack clamps (Jenkins, 1986).

A study of the type of *Amanita virginiana* was reported in (Jenkins, 1979). It has a grayish pileus; its spores, basidia, and stipe acrophysalides are all of differing dimensions than those of *A. ristichii*; and its basidia lack clamps.

Amanita submembranacea var. *bispora* is very much larger than *A. ristichii*, has an exannulate stipe, a deeply colored pileus, and mostly globose to subglobose spores (Reid, 1987).

Krieger preserved Kr. 224 as a voucher from which he had painted an excellent watercolor (also in FH) showing Kr. 224 whole and in longitudinal section. The specimen is in poor condition, but large spores and acrophysalidic stipe context are to be seen. The watercolor leaves little doubt as to the identity of the collection; it represents very clearly all major macroscopic characters except the presence of an internal limb in the volva. The specimen is accompanied by three pages of discursive description by Krieger and a note in the handwriting of W. D. Farlow which summarizes some of Krieger's description and adds notes on the spores including the observation that ''some spores were monstrous, as large as 6 div. × 4 1/2 div.'' Krieger's notes are the source of my information about the anastomosing of lamellae and striation of the upper surface of the annulus. He also mentions previously having collected the entity in 1904 in Chocorua; however, I have not located a 1904 collection. Because the few spores I found in Kr. 224 were on the stipe and, in some cases, were damaged, I have not included their measurements in the data on basidiospores, above. The eight spores measured fell into the following range: 12.0 - 15.0 × 6.5 - 9.4 μm.

In the field, *A. ristichii* might be confused with *Amanita alba* ss. auct. amer. (=*A. vaginata* var. *alba* ss. auct. amer.) as described in North American field guides and floristic studies (e.g., see Miller & Farr (1975) and Thiers (1982)). *Amanita ristichii* can be distinguished by many characters including the size and shape of its spores, the more robust universal veil, pale orange or pinkish gills drying a similar color, annulate stipe, and bisterigmate basidia.

In correpondence I have used the designation ''species N1'' for the taxon here named *Amanita ristichii.*

ACKNOWLEDGMENTS

I thank Dr. David T. Jenkins, Department of Biology, University of Alabama at Birmingham, for his review of this paper. I am very grateful to Dr. Jean R. Boise and Mr. Gennaro Concavio for their assistance at FH. I gratefully acknowledge the following assistance in the preparation of this paper: Mr. Neal Macdonald, Princeton, New Jersey, provided the illustrations. Mr. David C. Tulloss, Princeton, New Jersey, assisted with numerical computations. All Maine specimens were communicated to me by Dr. Samuel S. Ristich, Cumberland Center, Maine. Proofreading of final layout was done with the assistance of Ms. Mary A. King, Roosevelt, New Jersey.

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SCYTALIDIUM VACCINII SP. NOV., AN ERICOID ENDOPHYTE OF VACCINIUM ANGUSTIFOLIUM ROOTS.

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SUMMARY

Scytalidium vaccinii n. sp., a slow-growing dematiaceous hyphomycete isolated from cortical root cells of a mature blueberry plant, is illustrated and described. Its growth and nutritive requirements are presented and its mycorrhizal potential compared with other known ericoid mycorrhizal fungi.

RESUME

Scytalidium vaccinii n. sp., un hyphomycete dématié à croissance lente isolé des cellules corticales de racines de bleuets est illustré et décrit. Des données de croissance et de nutrition sont présentées et le potentiel mycorhizien comparé à celui d'autres symbiotes connus.

INTRODUCTION

The known causal organisms of ericoid mycorrhizae are slow-growing fungi giving dark-pigmented cultures. The sterile strains of Mycelium radicis myrtillis (Freisleben, 1936) and the dark sterile colonies described by Singh (1974) remain unidentified. The Helotiaceous Hymenoscyphus ericae (Read) Korf & Kernan (= Pezizella ericae Read, (1974)), and hyphomycetes of the genus Oidiodendron (Couture & al. 1983; Dalpé, 1986) are proven mycorrhizal symbionts of ericaceous hosts. In an attempt to evaluate benefit from different strains of H. ericae to young blueberry plantlets (Smagula & Litten, 1989), an authenticated isolate from England was compared with two isolates from roots of *Vaccinium angustifolium* Ait. of Maine. One of the Maine isolates was identified as *H. ericae*, but the other, although resembling *H. ericae* in growth rate and colony characteristics, differs in producing an arthroconidial anamorph which is described below as a new species of *Scytalidium*. This fungus is particularly active in the colonisation of the cortical root cells of blueberry plants and is the first species of *Scytalidium* known to form ericoid mycorrhizae.

MATERIAL AND METHODS

The specimen of *Vaccinium angustifolium* was obtained from a long established commercial blueberry field in Washington County, Maine. Cortical root cells were separated by maceration of hair roots of a mature plant (Pearson and Read, 1973), plated on water agar, and the outgrowing colonies transfered after 48 days to modified Melin-Norkrans medium (MMN) (Marx, 1969). Subsequent transfers to MMN were made after 35 and 104 days. The fungus was then grown and maintained on potato dextrose agar (PDA), malt agar (MA) (Difco), Corn Meal Agar (CMA), and on the synthetic medium of Mitchell and Read (1981) enriched with 0.5% of sucrose. Material for microscopic examination was obtained from these media and from tap water agar (TWA); slide cultures were made using Pablum cereal agar without antibiotics (CER) and oatmeal-salts agar (OAT) (Padhye et al., 1973). The mycorrhizal status of the fungus was then tested on axenic *V. angustifolium* seedlings (Dalpé, 1986). Root systems were stained with Malachite Green and Fuchsin, acid (Alexander, 1980) and their colonization levels estimated by the percentage of cortical root cells filled by hyphal coils. Optimum temperature, pH, vitamin, nitrogen and carbohydrate requirements for growth were studied. Cellulolytic activity was evaluated by the method of Yeoh et al. (1985). Fluorescence under ultraviolet was observed with an Optiphot Nikon microscope equipped with an episcopic-fluorescence attachment "EF"/"EFA", excitation and auxiliary filter UV 330-380 and an absorption filter 420 K.

DESCRIPTION OF THE FUNGUS

Scytalidium vaccinii Dalpé, Litten et Sigler sp. nov. Figs.1-7

Coloniae in PDA et MA, lente ad 20°C crescentes, densae, brunneae ad olivaceae-brunneae supra et infra, anguste hyalinae ad albae ad marginem, superficiei coactae, aerio mycelio albo ad cineraceo, filis hyphorum brunneis ad fumosis ad centrum. Coloniae in MA, azonateae; coloniae in PDA, plus minusve radiatim sulcatae, crassae, vix zonatae ad marginem, venetae prope marginem ad 10° vel temperaturam inferiorem. Crescentia nulla ad 40°C temperaturam. Mycelium aerium et immersum. Vegetativae hyphae, laeves, 2-3 um latae, subhyalinae ad brunneolae, ramosae, septatae, inflatis cellulis. Fertiles hyphae laeves, hyalinae ad subhyalinae, septatae, schizolitice secedentibus arthroconidis. Arthroconidia hyalina ad subhyalina, cylindracea, 0(1)-septata, 5.5-11 x 1.5-2.5 um in CER et OAT; arthroconidia subhyalina ad flavo-brunnea ad olivaceo-brunnea, cylindracea ad oblongo-elliptica, pandurata vel doliformia, laevia, guttulata 7-14(16) x (2)3-4(5) in TWA, PDA et MA. Conidia ubi catenata valde flexuosa, raro armilla relicta ad disjunctionem. Teleomorphosis ignotus.

Scytalidium vaccinii Dalpé, Litten et Sigler sp. nov. Figs 1-7

Colonies on PDA and MA growing slowly at 20°C (22 mm on MA, 25 mm on PDA after 15 days of incubation), with dense, brown to olive-brown, front and reverse, narrow hyaline to white margin, felted surface, white to gray aerial mycelium, brown to gray-brown hyphal strands developing toward the centre of older colonies. Colonies on MA, flat, without zonation; colonies on PDA, more or less radially folded, thick and scarcely zonated toward the margin, bluish-green near the margin at 10°C or lower temperatures. No growth at 40°C. Mycelium aerial and immersed. Vegetative hyphae smooth, 2-3 um wide, subhyaline to pale brown, branched, sparsely to regularly septate, sometimes slightly constricted at the septa, and often with individual cells rather variable in shape and slightly swollen; hyphae sometimes aggregating into strands. Fertile hyphae scarcely differentiated from vegetative hyphae, smooth, hyaline to subhyaline, with septa more closely spaced, fragmenting by schizolytic dehiscence to form arthroconidia. As with other arthroconidial fungi, arthroconidia vary in width depending on the width of the parent hypha. Arthroconidia most abundant and uniform on CER and OAT, hyaline to subhyaline, cylindrical, 0(1)-septate, measuring 5.5 - 11 x 1.5 - 2.5 um. On TWA, PDA and MA, arthroconidia subhyaline to yellow-brown or olive-brown, and more variable in width, measuring 7-14(16) x (2)3-4(5) um, and in shape, cylindrical to oblong-elliptical, panduriform or doliiform, smooth, guttulate. Conidia often remaining connected in zig-zag chains, rarely with a small frill of wall remaining at disjunction. Teleomorph unknown.

Holotype: Dried agar culture isolated from the cortical root cells of Vaccinium angustifolium, "Blueberry barrens", Washington County, Maine 30 Apr. 1986. Deposited in DAOM #196925. Microscope slides of mycelium and colonized roots of Vaccinium angustifolium are filed as DAOM 210088. Living subcultures deposited in CCFC as DAOM 196925 and in UAMH as 5828.

Scytalidium vaccinii growth requirements
Optimal temperature for growth of S. vaccinii was 20°C at a pH of 5.5. No growth occurred below 5° C and a pH of 4.5, or over 40°C and a pH of 8.0. The strain developed a turquoise pigmentation at the colony margin when exposed to 10°C or lower temperatures. This pigmentation faded gradually to an olive-brown tint in cultures grown at higher temperatures. Growth was supported by several nutritive media such as PDA, MA, CMA, and the synthetic Mitchell & Read (1981) medium enriched with 5% sucrose. In the Mitchell & Read medium free of sucrose, the strain completely lost its pigmentation; with the same medium, both organic and inorganic nitrogen sources such as NaNO3, NH4NO3, glutamine, asparagine and methionine were utilized and no vitamin deficiency was observed. S. vaccinii shows strong cellulolytic activity. Growth was inhibited by benomyl at 0.01% and by chloramphenicol at 100 p.p.m.

Vaccinium angustifolium root colonization
Under axenic culture conditions S. vaccinii produced typical hyphal coils comparable in morphology to those of other known ericoid mycorrhizal fungi (Fig.8). Young roots of seedlings were first surrounded

by a loose weft of pale pigmented hyphae. As the roots extended, extraradical mycelium became scantier and root cortical cells were gradually colonized. Root penetration was first observed after two weeks of incubation. Colonization level attained its maximum six weeks later; a mean of 42% of the cortical cells were filled with hyphal coils detectable by both root staining and ultra-violet autofluorescence (Fig.9). Under the same growing conditions in the same incubation time (Dalpé, 1986), the level of root colonization of blueberry seedlings was 9% with Oidiodendron rhodogenum, 21% with O. griseum, and 25% with Hymenoscyphus ericae (unpublished data). Similar tests with two strains of Scytalidium lignicola Pesante (DAOM 57215; 117429) and an unidentified Scytalidium species (DAOM 198535 = UAMH 6045) did not result in mycorrhizal infection.

DISCUSSION

Since Pesante (1957) described the hyphomycete genus Scytalidium typified by S. lignicola, twelve additional species and a synanamorph of the coelomycete Hendersonula toruloidea Nattrass have been added. Although several species are regularly associated with plant material, this is the first species shown to form a mycorrhizal association.

Hendersonula toruloidea is a fairly widespread pathogen of stone and other fruit trees (Punithalingam & Waterston, 1970) in tropical and subtropical areas. In recent years, it has become well-known as a recalcitrant agent of dermatomycosis and onychomycosis in individuals from the areas of the world where the fungus is a common plant pathogen. While the majority of isolates of H. toruloidea can be readily differentiated from S. vaccinii by their black colonies with aerial strands of broad hyphae (up to 10 um wide), rapid growth rate and production of characteristic pycnidia, our new species is similar in growth rate and colony characteristics to clinical isolates recorded as Form 3 by Moore (1988).

Moore distinguished three forms of H. toruloidea on growth rates, growth temperature, production of pycnidia, and hyphal and arthroconidial characteristics. Since the Form 3 group produced no pycnidia, Moore was unable to make a definitive identification of them as H. toruloidea, but the morphology of the Scytalidium arthroconidia and the clinical origin of the isolates suggested a close affinity. Form 3 isolates are not yet known from plant material; Moore has suggested that the slow-growing forms may represent an evolution of a more represent an evolution of a more aggressive human pathogen with an anthropophilic mode of transmission. Two Canadian isolates of H. toruloidea from human infection (UAMH 5396 and 6290), examined by the

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Fig.1. Scytalidium vaccinii. Colony on PDA. Fig.2. Hyphal strand (scale = 16um). Fig.3-4. Hyphae with swollen cells from TWA (scale = 16 um). Fig.5-6. Unbranched and branched fertile hyphae from CER dividing by schizolytic dehiscence to form arthroconidia remaining connected in zig-zag chains (scale = 20um). Fig.7. Chains of mature arthroconidia from TWA (scale = 20um). Fig.8-9. Colonized root sections of Vaccinium angustifolium seedlings (scale = 16um). Fig.8. Trypan Blue (0.2% in lactoglycerol). Fig.9: Ultraviolet fluorescence.

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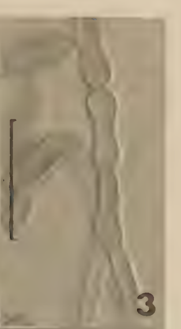
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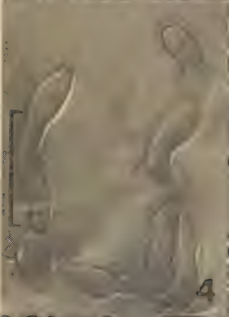
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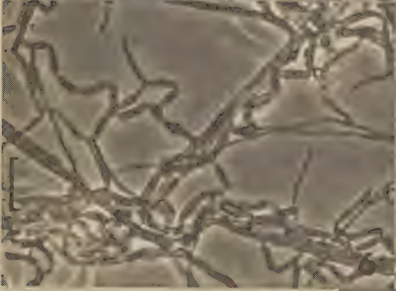
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junior author, demonstrate the features characteristic of Form 3. They grow more slowly, produce no pycnidia, and the hyphae are narrower (2-5 um broad) and bear distinctive excrescences on the surface. In addition, hyphal coils and loops are common and portions of the hyphae may be surrounded by brown slime. The arthroconidia of the Scytalidium morph are more variable in width, mostly 3-4 um wide but often rounding up at maturity to a width of 6 um, dark brown, and often 1-septate. S. vaccinii differs in having smooth hyphae, arthroconidia which are hyaline to subhyaline or yellow-brown and narrower. A few hyphal loops were seen in slide culture preparations on CER.

Scytalidium fulvum Morgan-Jones & al (1984), isolated from cysts of Heterodera glycines Ichinohe from soybean field soil in Alabama, is also slow-growing but the colonies are dark grey and the conidia are larger.

Several isolates of microfungi have previously been reported from roots of Ericaceae (Doak, 1928; Freisleben, 1936; Bain, 1937; Singh, 1974). Most of them were not taxonomically identified but the majority were described as non-sporulating, slow-growing dark-pigmented mycelia. S. vaccinii shows some similarities with the dark-sterile (DS) forms previously described by Singh (1974) related to the slow growth rate, the same olive to olive brown tint of colony pigmentation and the presence of aerial pigmented fascicles. However, the presence of aseptate arthroconidia in our strain directly affiliated it to the genus Scytalidium.

Colonies of S. vaccinii are easily confused with Hymenoscyphus ericae ones. Cultures of both species have a white margin with a brown to olive brown central colony and aerial pigmented hyphal strands (Vegh & Gianinazzi-Pearson, 1979). Microscopically, H. ericae filaments differ from those of S. vaccinii in that hyphae of the former are divided into numerous segments highly variable in form, length, and width (5.5-25-60) X 2-5.5 um) quite different from arthroconidia of S. vaccinii.

The S. vaccinii isolate invaded roots of V. angustifolium seedlings more aggressively than did other known ericoid mycorrhizal fungi. The benefit to the plant of inoculation with S. vaccinii has not been demonstrated under nursery procedures (Smagula & Litten, 1989). In view of the acceleration of root development found by Pons et al. (1982) in plantlets of Vaccinium myrtillus L. and Calluna vulgaris (L.) Hull by inoculation with H. ericae, further studies are under way to compare inoculations with H. ericae and S. vaccinii in promoting rooting and growth of V. angustifolium tissue-culture explants in sterilized and unsterilized conditions.

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THE LICHEN FLORA OF QAANAAQ (THULE), NORTHWESTERN GREENLAND

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SUMMARY

The present investigation of occurrence of lichens around Qaanaaq in northwestern Greenland is based on a study of more than 800 collections of 144 species of macro- and microlichens collected by the author in the summer of 1986. Six species are additions to the known lichen flora of Greenland, viz. Absconditella delutula (Nyl.) Coppins & Kilias, Bryonora rhypariza (Nyl.) Poelt, Buellia pulverulenta (Anzi) Jatta, Caloplaca psoricida E.S. Hansen, Poelt & Søchting, Catapyrenium squamulosum (Ach.) O. Breuss and Cladonia alaskana A. Evans. Beyond this, range extensions are given for 55 species. The most important epigeic and epilithic lichen communities are surveyed. The paper also comprises information on topography, geology and climate of the Qaanaaq area.

INTRODUCTION

Until recently northwestern Greenland has been in lack of lichenological investigations, mainly because of difficult of access. Some small collections of lichens made by, e.g., P. Freuchen, M.P. Porsild and W.S. Benninghoff & H.C. Robbins are, however, available from the start and the middle of the twentieth century.

The collection work as regards lichens was intensified in the Thule District in the seventies, first by A. Züst, who collected 50 taxa of lichens on the Carey Islands (76°44'N, 73°11'W)(Thomson 1978) and then by L. de Bonneval and B. Fredskild, who collected 77 taxa of macro- and microlichens in four areas situated in northwestern Greenland including Qaanaaq. The last-mentioned collections were determined by the present author (E.S. Hansen 1980). The total number of taxa of lichens known from this part of Greenland now amounted to about 100.

In the summer of 1981 L. Hansson collected 63 species of

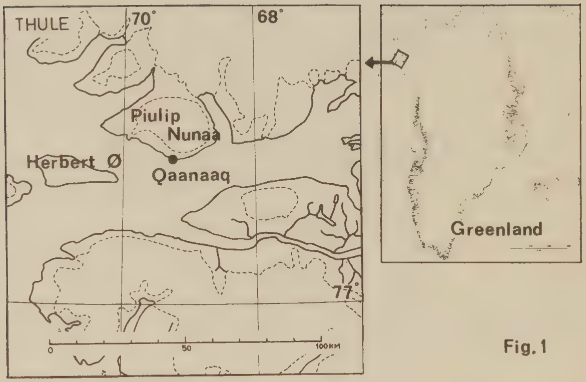


Fig. 1. Location of Qaanaaq (Thule) in Greenland.

lichens at Qaanaaq and three localities to the south of Qaanaaq (E.S.Hansen 1983). Her collections added 15 species to the known lichen flora of northwestern Greenland and gave us new knowledge about the vegetation of Iterdlak (76°19'N, 69°15'W) and Narssârssuk (76°26'N, 69°12'W).

The present author visited Qaanaaq in the summer of 1986 with the purpose of investigating the lichen flora of the surroundings of Qaanaaq. The population moved from the settlement Uummannaq at Thule Air Base to Qaanaaq in 1953. The environment appears to be only slightly influenced by the inhabitants of Qaanaaq (E.S. Hansen 1987). With this paper it is the intention to give a survey of the lichen flora and vegetation of the Qaanaaq area. The collected lichen material is deposited at the Botanical Museum, University of Copenhagen.

TOPOGRAPHY, GEOLOGY AND CLIMATE

Qaanaaq (77°29'N, 69°12'W) is situated near the south point of Piulip Nunaa peninsula that is partly covered by a central icecap (Fig. 1). The maximum elevation of this icecap, from which several glaciers, e.g., Qaanaaq Gletscher, radiate, is unknown. An altitude of 578 m a.s.l. has, however, been measured at a site located exactly to the north of Qaanaaq and close to the icecap. The mountainous ground slopes down from the icecap towards the inlet Inglefield Bredning (Kangerdlugssuaq) under formation of more or less distinct terraces and large talus slopes. Glacial streams form broad deltas on the marine foreland. The town Qaanaaq is founded on this foreland. The shortest distance between the icecap and the coastline is about 2 km, only.

The geological conditions of the Thule area are strongly influenced by late Proterozoic sedimentary rocks of the Wolstenholme Formation (Escher & Stuart Watt 1976) that overlies the Archaean-Proterozoic crystalline basement. The Wolstenholme Formation, which together with the Dundas Formation and the Narssârssuk Formation constitute the Thule Group, consists of four units: 1. a basal, multicoloured one with ferruginous sandstone, shale and different volcanic rocks. 2. a white to pink unit of quartzite with conglomerate. 3. a red unit of ferruginous sandstone, siltstone, shale and conglomerate. 4. a brownish yellow to yellow unit of sandstone, quartzite and quartz pebble conglomerate. The above-mentioned rocks are intruded and cut by dolerite sills and dykes. Weathering and frost erosion of the rocks has resulted in stones and boulders that cover the ground almost totally in many places around Qaanaaq. Visible layers of sandstone and shale appear, however, to the east and to the west of the town. Large, ice transported, gneissic boulders occur rather frequently in the marine foreland. Their degree of hardness is greater than that of the sandstones, and they carry another type of lichen flora.

Table 1. Mean temperatures (°C), precipitation (mm) and snow depth (cm) of the months in Qaanaaq (measurements made by the Danish Meteorological Institute 1964-1980; snow depth 1964-1977).

	J	F	M	A	M	J	J	A	S	O	N	D	Year
Mean temperatures	-21.8	-22.7	-22.7	-16.4	-5.2	1.3	4.3	4.6	-1.3	-7.8	-15.5	-20.8	-10.5
Precipitation	5.3	6.9	3.7	5.3	5.0	7.5	25.1	21.3	13.1	6.6	4.5	3.0	91.7
Snow depth	23.8	26.2	28.9	32.1	24.0	3.1	0	0	2.9	11.7	18.1	20.8	16.1

Qaanaaq has a high arctic and somewhat continental climate according to meteorological data available from the weather station situated in the northern part of the town (cf. Table 1). The mean temperature of the warmest month, August, is 4.6°C, while the mean temperature of the coldest months, February and March, is -22.7°C. The annual temperature amplitude is 27.3°C. Extremely low temperatures occur commonly during the winter. The average annual precipitation at Qaanaaq is 91.7 mm, most of it falling as snow. The amount of precipitation is greatest in July and August. The snow depth is greatest in April. In July and August the snow disappears totally from the ground in the lowlands. Formation of fog is frequent during the summer. The polar night lasts for a period of three and a half months (Oct. 28-Febr. 15).

LIST OF SPECIES

In the following an outline will be given of the lichens found in the Qaanaaq area except some additional, critical lichens that await further determination. The species (and a single subspecies) are listed alphabetically within the families. These are arranged according to the outline of the Ascomycetes presented by Eriksson & Hawksworth (1988). Nomenclature follows Santesson (1984) with subsequent changes given by, e.g. Hertel & Rambold (1987) and Rogers & Hafellner (1988). An asterisk in front of the name indicates that the species is an addition to the known lichen flora of northwestern Greenland (73°N-80°N), two asterisks that the species is new to the whole Greenland. Presence of apothecia or perithecia are indicated by "c.ap." and "c.pe", respectively. "st." means that the specimens found are sterile.

Class Ascomycetes

Acarosporaceae
   Acarospora chlorophana (Wahlenb. in Ach.) Massal. (c.ap.)
 * Acarospora sinopica (Wahlenb. in Ach.) Koerb. (c.ap.)
 * Acarospora smaragdula (Wahlenb. in Ach.) Massal. (c.ap.)
   Sporastatia testudinea (Ach.) Massal. (c.ap.)
Alectoriaceae
   Alectoria nigricans (Ach.) Nyl. (st.)
   Alectoria ochroleuca (Hoffm.) Massal. (st.)
Arthrorhaphidaceae
 * Arthrorhaphis citrinella (Ach.) Poelt (st.)
Baeomycetaceae
 * Baeomyces placophyllus Ach. (st.)
 * Baeomyces roseus Pers. (st.)
Candelariaceae
   Candelariella athallina (Wedd.) Du Rietz (c.ap.)
   Candelariella aurella (Hoffm.) Zahlbr. (c.ap.)
   Candelariella placodizans (Nyl.) H.Magn. (c.ap.)
   Candelariella vitellina (Hoffm.) Müll. Arg. (c.ap.)
   Candelariella xanthostigma (Ach.) Lettau (st.)
Cladoniaceae
** Cladonia alaskana A. Evans (st.)
   Cladonia amaurocraea (Flk.) Schaer. (st.)
   Cladonia arbuscula (Wallr.) Flotow ssp. mitis (Sandst.) Rouss (st.)
 * Cladonia cariosa (Ach.) Spreng. (c.ap.)
   Cladonia cenotea (Ach.) Schaer. (st.)
   Cladonia chlorophaea (Flk. ex Sommerf.) Spreng. s.lat. (st.)
   Cladonia coccifera (L.) Willd. (c.ap.)
 * Cladonia cornuta (L.) Hoffm. (ssp. groenlandica (E.Dahl) Ahti)(st.)
 * Cladonia ecmocyna Leight (st.)
 * Cladonia fimbriata (L.) Fr. (st.)
   Cladonia gracilis (L.) Willd. (st.)
 * Cladonia luteoalba A. Wils. & Wheld. (st.)

* Cladonia macroceras (Flk.) Ahti (st.)
Cladonia macrophylla (Schaer.) Stenham. (st.)
Cladonia pleurota (Flk.) Schaer. (st.)
Cladonia pyxidata (L.) Hoffm. (st.)
* Cladonia squamosa (Scop.) Hoffm. (st.)
Cladonia stricta (Nyl.) Nyl. (st.)
Collemataceae
* Leciophysma finmarkicum Th. Fr. (c.ap.)
Coniocybaceae
* Coniocybe furfuracea (L.) Ach. (c.ap.)
Hymeneliaceae
* Tremolecia atrata (Ach.) Hertel (c.ap.)
Lecanoraceae
* Bryonora castanea (Hepp) Poelt (c.ap)
** Bryonora rhypariza (Nyl.) Poelt (c.ap.)
* Lecanora atrosulphurea (Wahlenb.) Ach. (c.ap.)
* Lecanora badia (Pers.) Ach. (c.ap.)
* Lecanora behringii Nyl. (c.ap.)
* Lecanora contractula Nyl. (c.ap.)
Lecanora epibryon (Ach.) Ach. (c.ap.)
* Lecanora geophila (Th. Fr.) Poelt (st.)
* Lecanora intricata (Ach.) Ach. (c.ap.)
* Lecanora marginata (Schaer.) Hertel & Rambold (c.ap.)
Lecanora polytropa (Hoffm.) Rabenh. (c.ap.)
* Miriquidica nigroleprosa (Vain.) Hertel & Rambold (c.ap.)
Rhizoplaca melanophthalma (DC. in Lam. & DC.) Leuckert & Poelt (c.ap.)
Lecideaceae
Lecidea atrobrunnea (DC. in Lam. & DC.) Schaer. (c.ap.)
Lecidea auriculata Th. Fr. (c.ap.)
Ophioparmaceae
Ophioparma ventosa (L.) Norman (c.ap.)
Pannariaceae
* Pannaria pezizoides (Web.) Trevis. (c.ap.)
Psoroma hypnorum (Vahl) S.F. Gray (c.ap.)
Parmeliaceae
Bryocaulon divergens (Ach.) Kärnef. (st.)
* Bryoria nitidula (Th. Fr.) Brodo & Hawksw. (st.)
Cetraria cucullata (Bell.) Ach. (c.ap.)
Cetraria delisei (Bory ex Schaer.) Nyl. (st.)
Cetraria islandica (L.) Ach. (st.)
Cetraria nigricans Nyl. (st.)
Cetraria nigricascens (Nyl.) Elenkin (st.)
Cetrareia nivalis (L.) Ach. (st.)
Coelocaulon muricatum (Ach.) Kärnef. (st.)
Dactylina arctica (Hook.) Nyl. (st.)
Dactylina ramulosa (Hook.) Tuck. (st.)
Hypogymnia austerodes (Nyl.) Räs. (st.)
Hypogymnia oroarctica Krog (st.)
* Hypogymnia physodes (L.) Nyl. (st.)
* Hypogymnia subobscura (Vain.) Poelt (st.)
Parmelia alpicola Th. Fr. (st.)
Parmelia disjuncta Erichs. (st.)
* Parmelia incurva (Pers.) Fr. (st.)
Parmelia infumata Nyl. (st.)
Parmelia omphalodes (L.) Ach. (st.)

Parmelia saxatilis (L.) Ach. (st.)
Parmelia sulcata Tayl. (st.)
Pseudephebe minuscula (Nyl. ex Arn.) Brodo & Hawksw. (st.)
Pseudephebe pubescens (L.) Choisy (st.)

Peltigeraceae

* Peltigera didactyla (With.) Laundon (st.)
* Peltigera lepidophora (Nyl.) Bitter (st.)
Peltigera leucophlebia (Nyl.) Gyeln. (st.)
Peltigera malacea (Ach.) Funck (st.)
* Peltigera neckeri Müll. Arg. (st.)
Peltigera rufescens (Weis.) Humb. (st.)
Solorina bispora Nyl. (c.ap.)
Solorina crocea (L.) Ach. (c.ap.)

Pertusariaceae

Ochrolechia frigida (Sw.) Lynge (c.ap.)
Ochrolechia grimmiae Lynge (c.ap.)
* Ochrolechia upsaliensis (L.) Massal. (c.ap.)
Pertusaria dactylina (Ach.) Nyl. (st.)
Pertusaria oculata (Dicks.) Th. Fr.(st.)

Physciaceae

** Buellia pulverulenta (Anzi) Jatta (c.ap.)
* Dimelaena oreina (Ach.) Norm. (c.ap.)
Phaeophyscia sciastra (Ach.) Moberg (st.)
Physcia caesia (Hoffm.) Fürnrohr (st.)
Physcia dubia (Hoffm.) Lettau (st.)
Physconia muscigena (Ach.) Poelt (c.ap.)
* Rinodina roscida (Sommerf.) Arn. (c.ap.)
Rinodina turfacea (Wahlenb.) Koerb. (c.ap.)

Placynthiaceae

* Placynthium asperellum (Ach.) Trevis. (st.)

Porpidiaceae

Porpidia pseudomelinodes Schwab (st.)

Psoraceae

* Lecidoma demissum (Rutstr.) G. Schneider & Hertel (c.ap.)
* Psora rubiformis (Ach.) Hook. (c.ap.)

Rhizocarpaceae

Orphniospora moriopsis (Massal.) Hawksw. (c.ap.)
Rhizocarpon geminatum Koerb. (c.ap.)
Rhizocarpon geographicum (L.) DC. (c.ap.)
* Rhizocarpon grande (Flk. ex Flot.) Arn. (c.ap.)
* Rhizocarpon pusillum Runem. (c.ap.)
* Rhizocarpon renneri Poelt (c.ap.)

Sphaerophoraceae

Sphaerophorus fragilis (L.) Pers. (st.)
Sphaerophorus globosus (Huds.) Vain. (st.)

Stereocaulaceae

Stereocaulon alpinun Laur. (c.ap.)
Stereocaulon arenarium (Sav.) Lamb. (c.ap.)
Stereocaulon rivulorum H. Magn. (c.ap.)

Stictidaceae

** Absconditella delutula (Nyl.) Coppins & Kilias (c.ap.)

Teloschistaceae

* Caloplaca alcarum Poelt (c.ap.)
* Caloplaca ammiospila (Ach.) Oliv. (c.ap.)
* Caloplaca celata Th. Fr. (c.ap.)

Caloplaca cerina (Ehrh.) Th. Fr. (c.ap.)
* Caloplaca epiphyta Lynge (c.ap.)
* Caloplaca epithallina Lynge (c.ap.)
* Caloplaca jungermanniae (Vahl) Th. Fr. (c.ap.)
* Caloplaca lithophila H. Magn. (c.ap.)
** Caloplaca psoricida E.S. Hansen, Poelt & Søchting (c.ap.)
* Caloplaca saxifragarum Poelt (c.ap.)
* Caloplaca tetraspora (Nyl.) Oliv. (c.ap.)
Caloplaca tiroliensis Zahlbr. (c.ap.)
Xanthoria candelaria (L.) Th. Fr. (st.)
Xanthoria elegans (Link) Th. Fr. (c.ap.)
* Xanthoria sorediata (Vain.) Poelt (st.)

Trapeliaceae
* Trapeliopsis granulosa (Hoffm.) Lumbsch (st.)

Umbilicariaceae
Umbilicaria arctica (Ach.) Nyl. (c.ap.)
Umbilicaria cylindrica (L.) Del. ex Duby (c.ap.)
Umbilicaria decussata (Vill.) Zahlbr. (c.ap.)
Umbilicaria hyperborea (Ach.) Hoffm. (c.ap.)
Umbilicaria lyngei Schol. (st.)
Umbilicaria proboscidea (L). Schrad. (c.ap.)
Umbilicaria torrefacta (Lightf.) Schrad. (c.ap.)
Umbilicaria virginis Schaer. (c.ap.)

Verrucariaceae
* Catapyrenium cinereum (Pers.) Koerb. (c.pe).
* Catapyrenium daedaleum (Krempelh.) B. Stein (c.pe.)
** Catapyrenium squamulosum (Ach.) O. Breuss (c.pe.)

Class Basidiomycetes

Tricholomataceae
Omphalina hudsoniana (Jenn.) Bigelow

Lichenes Imperfecti

* Cystocoleus ebenus (Dillw.) Thwaites
Lepraria neglecta Vain.
Thamnolia vermicularis (Sw.) Schaer.

TYPES OF VEGETATION RICH IN LICHENS

Very few ecological investigations have previously been carried out along with plant sociological research in northwestern Greenland. The floristic constitution of some important communities has been described by the present author (E.S. Hansen 1980, 1983). The following survey of the lichen vegetation and habitats around Qaanaaq is also purely descriptive, but it contains additional information on a number of ecological factors such as type of soil and rock, snow cover and influence of manuring.

A. EPIGEIC VEGETATION

Vaccinium uliginosum-Dryas integrifolia-Carex rupestris Sociation

This type of heath vegetation covers large patches on south- and southeast exposed slopes to the north of Qaanaaq, particularly in areas that are early free of a protecting snow cover and therefore relatively dry during summer. The layer of soil is often very thin. The soil is a mixture of clayey and sandy weathering material and some organic material. It has a slightly acid reaction. Salix arctica, Silene acaulis and Hierochloë alpina occur more or less constantly in this sociation.

The sociation is comparatively rich in lichens (max. 20 taxa), Cetraria cucullata being the most abundant species. Thamnolia vermicularis and Coelocaulon muricatum are additional important lichens also occurring in more dry types of dwarf shrub heaths and in fell-fields in other parts of Greenland (Gelting 1955; E.S. Hansen 1978a & b). It is of interest that Cetraria nivalis is of minor importance, only. Gelting (1955) found that it is a constant species in a Dryas integrifolia community analysed by him on Disko. The occurrence of Psora rubiformis and other eutrophic lichens in the corresponding heath type at Qaanaaq show that the soil is comparatively rich in nutrition.

Alectoria nigricans, Bryoria chalybeiformis and Cetraria cucullata are the dominant lichens in a Vaccinium uliginosum-Carex rupestris heath near the above-mentioned patches. It is very rich in crustaceous species, e.g. Caloplaca ammiospila, Ochrolechia upsaliensis and Pertusaria dactylina, but generally these lichens cover very small areas, only.

Dead tufts of Dryas often carry a rich vegetation of Caloplacas, e.g. C. cerina, C. tiroliensis and C. ammiospila. Caloplaca jungermanniae and Leciophysma finmarkicum were found growing on dead fragments of Silene acaulis.

Cassiope tetragona Sociation

Cassiope tetragona forms a very dense type of vegetation in places with a prolonged snow cover, i.e., on east exposed slopes and in depressions on south and west exposed slopes. The soil has an upper, peaty layer that gradually changes into clay, sand and stones with a marked higher pH. Salix herbacea, S. arctica, Silene acaulis and Luzula confusa were found growing in this sociation, but in very small quantities, only.

Among the cryptogams Racomitrium lanuginosum and Cetraria nivalis are constant elements of the Cassiope heaths near Qaanaaq. About a dozen species of lichens are able to colonize the soil and dead plant fragments in these heaths, but Lepraria neglecta is the only lichen that covers larger, mossy patches. Arthrorhaphis citrinella, Candelariella placodizans and Lecanora geophila (Fig. 2) are pioneer plants on open soil among the dwarf shrubs.

Baeomyces placophyllus and B. roseus occur in a similar way along tracks on the slopes and in the lowlands. Cetraria cucullata is of minor importance in these Cassiope heaths that otherwise are rich in macrolichens commonly occurring in Greenland dwarf shrub heaths, e.g., Cladonia arbuscula ssp. mitis, C. amaurocraea, Cetraria nivalis and C. islandica (Fredskild 1961, E.S. Hansen 1979 a & b). A single growth of Cladonia luteoalba was found in an open Cassiope vegetation on the slope above Qaanaaq. Crustaceous lichens such as Lecidoma demissum, Ochrolechia frigida and Pertusaria dactylina cover small areas, only.

An open Cassiope tetragona-Vaccinium uliginosum heath is developed in places with a comparatively good drainage. Accordingly the soil is more dry in the summer period than in the other types of Cassiope vegetation. The peaty surface layer is rather thin. The underlying soil has a slight acid reaction. The Cassiope-Vaccinium heath is very rich in lichens (up to c. 20 species), some of which (e.g., Caloplaca ammiospila and Peltigera lepidophora) indicate that the soil is circumneutral, at least locally. The floristic composition of the heath is comparable with that of the above-mentioned Cassiope heath, but it is more rich in pioneer lichens and mosses. The mosses are often covered by crustaceous lichens such as Bryonora castanea and Psoroma hypnorum. Stereocaulon arenarium is an occasional component of the community.

An interesting variant of the Cassiope heath occurs in horizontal patches on some of the terraces above Qaanaaq. Here melting snow is found even in July. The soil is very moist during summer. Cetraria nigricascens is a constant component of these heath patches and sometimes is found in great abundance (E.S. Hansen 1986b). It also occurs on the east exposed slopes near Qaanaaq. After C. nigricascens was reported from Greenland (Melville Bugt) by the present author (E.S. Hansen 1981), it has been collected at Scoresbysund in Central East Greenland. There is an additional report from Peary Land (E.S. Hansen 1984). Accordingly the species belongs to the group of lichens that have a northern, high arctic distribution in Greenland. In addition it belongs to the Beringian element in the arctic (Thomson 1984). It is no matter for surprise that the moist Cassiope heaths with C. nigricascens are rich in plants otherwise known from snowbeds in other parts of Greenland, e.g., Salix herbacea and Cetraria delisei. At Qaanaaq Stereocaulon alpinum appears to have a particular preference for the Cassiope heaths. However, macrolichens are of minor importance in these very northern snowbeds. Thus Solorina crocea is comparatively rare in the Qaanaaq area.

Empetrum hermaphroditum-Vaccinium uliginosum Sociation

Empetrum hermaphroditum is a rare species in the Qaanaaq area. The plant only covers small areas at lower altitudes on the slopes. The soil is of the same type as that in the other Vaccinium communities. Macrolichens such as Cladonia arbuscula ssp. mitis, C. pyxidata, C. coccifera and Cetraria cucullata occur more or less abundantly in the sociation. Crustaceous lichens appear to be more rare than in the above-mentioned sociations.

Racomitrium lanuginosum-Cladonia alaskana Sociation

Racomitrium lanuginosum forms tussocks covering several square metres of ground in some places in the lowlands around Qaanaaq. A number of lichens occur scattered upon these tussocks, e.g., Dactylina arctica, Sphaerophorus globosus and Ochrolechia grimmiae. Cladonia alaskana (Fig. 3) grows in protected niches among sandstone boulders together with Racomitrium lanuginosum and lichens such as Bryoria nitidula, Cladonia cenotea, C. cornuta and C. squamosa. Omphalina hudsoniana belongs to this sociation, too. Like Cetraria nigricascens, Cladonia alaskana shows a wide amphi-Beringian range (E.S. Hansen 1989). The great waterholding capacity of Racomitrium probably determines the abundant occurrence of Cladonia stricta in the moss tussocks. Otherwise C. stricta is a dominant species on moist soil along the watercourses that carry melting water from the local accumulations of ice.

Mossy cliff rich in Peltigeras and other lichens

A few metres from the coast line somewhat to the east of Qaanaaq a low mossy cliff with scattered Dryas plants was studied. Four species or Peltigera occur on the cliff, viz. Peltigera didactyla, P. neckeri, P. rufescens and P. leucophlebia. Psoroma hypnorum, Caloplaca cerina, Lecanora epibryon and Physconia muscigena grow on and among mosses, too. Absconditella delutula (Fig. 4) that is an addition to the known lichen flora of Greenland was found growing on dead fragments of Dryas together with Caloplaca tetraspora, C. tiroliensis and Rinodina turfacea. Coniocybe furfuracea occurs in a small, somewhat moist and shady depression together with Cystocoleus ebenus, while Hypogymnia subobscura, Ochrolechia upsaliensis, Lecanora geophila and Candelarialla placodizans grow on more dry soil on the cliff.

B. EPILITHIC LICHEN VEGETATION

Umbilicaria hyperborea-Pseudephebe minuscula-Sporastatia testudinea Sociation

This sociation that is unique by its distinct dominance of Umbilicaria hyperborea has a wide distribution in the Qaanaaq area and occurs on garnet gneiss, quartz-pebble conglomerate and sandstone.

Ice transported boulders composed of garnet-hornblende or garnet-biotite gneiss occur scattered in the lowlands around Qaanaaq. The vertical surfaces of the blocks are partly covered by species such as Umbilicaria hyperborea, U. proboscidea, Pseudephebe minuscula, Parmelia disjuncta and the following microlichens: Sporastatia testudinea, Rhizocarpon geographicum, R. geminatum and Lecanora polytropa. The boulders act as resting-places for various birds and accordingly their tops are often covered by ornithocoprophilous lichens (see later).

The sociation is more common than the other epilithic sociations on sedimentary rocks in the Qaanaaq area. It is found on sandstone blocks both in the lowlands and at higher altitudes (up to c. 500 m a.s.l.). It consists of the above-mentioned species that grow on all types of surfaces of the sandstone boulders, even the apical faces. As many sandstones in the area are ferruginous, it sometimes can happen that Tremolecia atrata joins in the association. Umbilicaria lyngei, U. torrefacta, U. cylindrica, Parmelia incurva, Hypogymnia oroarctica, Ophioparma ventosa, Candelariella vitellina, Lecanora intricata and L. atrosulphurea are additional species found on these sandstone rocks. A somewhat reduced edition of the sociation occurs on scattered boulders composed of quartz-pebble conglomerate.

Acarospora chlorophana Sociation

Acarospora chlorophana occurs sparsely on southeast exposed slopes north of Qaanaaq. Here it was found growing on blocks of ferruginous sandstone of reddish brown colour and more rarely on pale sandstone (max. alt. 560 m a.s.l.). It was not found on the gneissic boulders. The plants consist of a few, scattered areoles with the characteristic bright lemon colour. Apothecia are present.

Creveld (1981) describes a Norwegian community with Acarospora chlorophana occurring on strongly overhanging faces of boulders and rocks and even in deep vertical crevices. In the same way most of the Greenland populations of A. chlorophana have a distinct preference for overhangs, rocky caves and crevices (E.S. Hansen 1982). However, the species is always found growing on exposed rocks in the Qaanaaq area. This partly can be explained by the fact that the polar night lasts for 3 1/2 months in this part of Greenland. Creveld (1981) found that A. chlorophana occurs regularly in the Umbilicaria-Sporastatia association in southern Norway, but the species is not present in the above-mentioned Umbilicaria hyperborea-Pseudephebe minuscula-Sporastatia testudinea sociation. The occurrence of A. chlorophana on substrates rich in iron has previously been reported by Wirth (1987).

Parmelia incurva Sociation

This association typically occurs in protected and somewhat moist places with a snow cover of long duration such as rocks near snowbeds and watercourses. Parmelia incurva sometimes grows together with Porpidia pseudomelinodes on boulders close to small streams with melting water. The species is particularly abundant on sandstone rocks in block fields in the lowlands. It has a distinct preference for the top and the subapical faces of the boulders. Parmelia incurva is always sterile and poor in soralia in the Qaanaaq area.

Acarospora sinopica Sociation

Although rocks with iron containing minerals occur abundantly around Qaanaaq, the content of Fe-oxides is rarely high enough to allow the Acarospora sinopica sociation to grow on them. It was found on some small, dark reddish brown blocks in a marsh somewhat to the east of Qaanaaq. Acarospora sinopica is of greatest importance, but species such as Tremolecia atrata, Umbilicaria hyperborea, Pseudephebe minuscula and Sporastatia testudinea also occur on the stones. Creveld (1981) states for some Norwegian rocks with Fe-minerals that they are mainly inhabited by Sporastatia-Pseudephebe communities. This also applies to a large part of the sandstone rocks of Qaanaaq. Rocks with a well-developed vegetation of species such as Acarospora sinopica, Lecidea atrofulva and L. silacea have been studied in South East Greenland by the present author (E.S. Hansen 1986a).

Dimelaena oreina Sociation

The sociation occurs on the previously mentioned gneissic boulders rich in garnet situated in the flat lowland near the inlet. The boulders have been transported by ice and have a comparatively smooth, but very hard surface. They are up to 1.5 m high and are more or less manured by birds. Dimelaena oreina is dominant on the apical and subapical surfaces of the boulders, where pH is higher than at the lower surfaces. The sociation is also considered ornithocoprophilous or nitrophilous in Central Europe (Klement 1950, 1955), whereas the Norwegian associations with Dimelaena oreina studied by Creveld (1981) do not show this characteristic. She found it to be restricted to steep and overhanging rock faces with southern exposure. In North Greenland (Thule, Peary Land) Dimelaena oreina has a distinct preference for the top and the subapical surfaces of the rocks and boulders, but occasionally it occurs on steep faces, too.

Xanthoria elegans, Umbilicaria decussata, U. hyperborea, Sporastatia testudinea, Pseudephebe minuscula, Candelariella vitellina and species of Physcia are additional important members of the sociation. Grey and yellow species of Rhizocarpon occur less frequently. The rare Greenland species Rhizocarpon renneri was found growing parasitically on Dimelaena oreina on one of the gneissic boulders at Qaanaaq.

Xanthoria elegans-Physcia caesia Sociation

This very conspicuous sociation has a wide distribution in the Qaanaaq area and occurs in all other parts of Greenland, too (Daniëls 1975; E.S.Hansen 1978 a & b, 1982; Salomonsen 1979; Moberg & E.S. Hansen 1986). It is found on both gneissic rocks and sandstones of different types and with varied exposure and slope. The species belonging to the sociation occur abundantly on the top of boulders, where birds, e.g. snowbuntings, like to rest, but are also

Fig.2

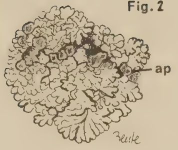
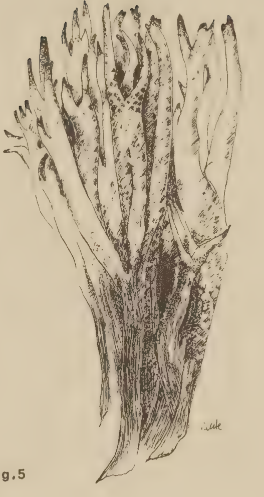


Fig.3



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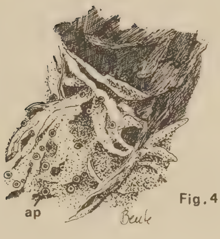

Fig.5

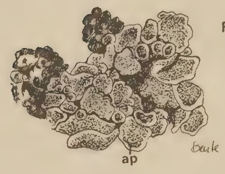

Fig.6

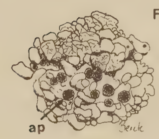

Fig. 2. Lecanora geophila (Th. Fr.) Poelt (x2). Fig. 3. Cladonia alaskana A. Evans (x2.5). Fig. 4. Absconditella delutula (Nyl.) Coppins & Kilias (x1.5). Fig. 5. Caloplaca alcarum Poelt (x8.5). Fig. 6. Buellia pulverulenta (Anzi) Jatta (x4.5). ap = apothecia.

found growing in great abundance on the rocks in places, where the dogs of Qaanaaq are kept, when they are not on sledge journeys.

Xanthoria elegans and Physcia caesia appear to be the most characteristic of the nitrophilous species on the above-mentioned rocks, followed by Umbilicaria decussata, Parmelia infumata, Physcia dubia, Rhizocarpon geminatum and Lecidea atrobrunnea. Species such as Sporastatia testudinea, Pseudephebe minuscula and Candelariella vitellina are constant elements of the sociation. The two parasitic species of Caloplaca, C. alcarum (Fig. 5) and C. epithallina that grow on the thalli of Lecanora contractula and Rhizoplaca melanophthalma, respectively, occur on boulders close to Qaanaaq. Presumably the occurrence of both of these species on these boulders indirectly is influenced by nitrogenous matters from dog droppings.

Xanthoria candelaria-Physcia dubia Sociation

While the preceding sociation can be found near the houses of Qaanaaq, the community dominated by Xanthoria candelaria and Physcia dubia occurs at some distance from the town. It occurs predominantly on the apical surface of boulders influenced by guano from, e.g. snowbuntings. The number of thalli of Xanthoria candelaria on such boulders can be very high. In extreme cases the species covers the whole top surface leaving only small patches for other lichens. Physcia dubia is sometimes replaced by P. caesia on the rocks that are composed either of sandstone or gneiss. Parmelia sulcata, Rhizoplaca melanophthalma and Lecanora badia are additional lichens of the community. In a few cases Xanthoria sorediata was found on the lower part of boulders otherwise overgrown by members of the Xanthoria candelaria-Physcia dubia sociation. Physcia dubia was found to be infested with Buellia pulverulenta (Fig. 6).

C. LICHENS GROWING ON BONES AND WOOD

Old bones of seal, narwhale and other marine mammals occur scattered on the ground in the lowlands around Qaanaaq. They are often covered by lichens, e.g. Physcia caesia, Caloplaca tiroliensis, C. cerina, Candelariella aurella and Lecanora behringii. Psoroma hypnorum was found growing over mosses on a bone.

Old wood is also a substrate for species such as Caloplaca tiroliensis and C. cerina (E.S. Hansen, Poelt & Søchting 1987).

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AZBUKINIA GEN. NOV.

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During studies on the pyrenomycetes of the soviet Far East by the author, some new species and genera were found, and one of the most exciting findings is the fungus recorded by Jaczewski (1913) as *Chailletia ferruginea* (Fuckel) Jacz. Unfortunately, the genus *Chailletia* Jacz. is invalid because of its thrice-repeated usage for various kinds of organisms (Hawksworth et al., 1983). So, a new genus is described here:

Azbukinia Lar. Vass., gen. nov.

Syn.: *Chailletia* Jacz., Opred. gribov (The handbook of fungi) 1: 233. 1913, nom. nud.; non *Chailletia* DC., Ann. Mus. Natl. Hist. Nat. 17: 153. 1811; non *Chailletia* Fuckel, Fungi Rhen. 6: 557. 1863; non *Chailletia* Karsten, Mycol. Fenn. 1: 21, 241. 1871.

Stromata eutypoidea, ligno decorticato insidentia vel verruciformiter elevata, effusa, confluentia vel irregulariter efformata, nigrescentia. Ostiola prominentia, distincte sulcata. Perithecia ligno immersa, ovoidea vel compressa, collo longi. Asci unitunicati, cylindrici, fasciculati, paraphysati, apparatu apicali nonamyloideo. Ascosporae uniseriales, ellipsoideae, incoloratae, dictyoseptatae.

Type species: *Azbukinia ferruginea* (Fuckel) Lar. Vass.

Azbukinia ferruginea (Fuckel) Lar. Vass., comb. nov.

Syn.: *Melanops ferruginea* Fuckel, Jahrb. Nassauischen Ver. Naturk. 27-28: 40. 1873.- *Botryosphaeria ferruginea* (Fuckel) Sacc. Syll. Fung. 1: 465. 1882. - *Chailletia* *ferruginea* (Fuckel) Jacz. Opred. gribov, 1: 233. 1913.

Stromata eutypoid, effuse or limited, sometimes very prominent and robust, black. Perithecia immersed, 500-600 μm diam, with sulcate ostioles and elongate beaks projecting beyond surface of stroma. Asci unitunicate, cylindrical, in fascicle, with numerous paraphyses and nonamyloid apical ring, 130-150 x 10-12 μm. Ascospores uniseriate, ellipsoid, 3-(4-)septate and one vertical septum, without constrictions, hyaline, 16-20 x 7-9 μm.

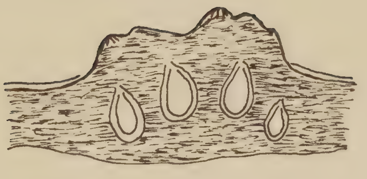
In woody plants, USSR, Primorski region, reservation "Kedrovaja Padj," October 1987, Lar. N. Vasilyeva.

The original description and illustration (Fuckel, 1873) indicated that the ascospores were one celled and contained four to six guttules. Winter (1887) made the observation that the fungus is dictyosporous. He provided no other disposition for the species, which he listed under *Botryosphaeria* as doubtful or to be excluded.

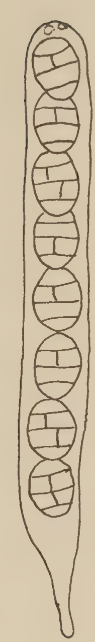
Jaczewski (1913) placed this fungus in the family Valsaceae among a very heterogeneous complex of genera (*Mamiania* Ces. et de Not., *Valsa* Fr., *Anthostoma* Nits., *Physalosporina* Woronich., *Botryosphaeria* Ces. et de Not., *Chailletia* Jacz., *Melogramma* Fr., *Kalmusia* Niessl, *Endothia* Fr., *Diaporthe* Nits., *Hercospora* Tul., *Rhynchostoma* Karst., *Myrmaecium* Nits.), which actually belong in Valsaceae, Gnomoniaceae, Diatrypaceae, Dothideaceae or Hypocreaceae.

The perithecial centrum of the fungus (i.e., fasciculate asci with paraphyses) is characteristic of the family Diatrypaceae in my new treatment (Vasilyeva, 1987, 1988) which includes all ascospore types (in contrast to more widely accepted "allantosporous concept," cfr. Eriksson and Hawksworth, 1986, pp. 218-219) and exhibits the complete parallelism to the family Valsaceae both in ascosporic and stromatal characters.

It should be noted that the genus *Azbukinia* falls on that place in the table of generic distribution in Diatrypaceae (Vasilyeva, 1987, p. 39) which was unoccupied before, i.e., it corresponds to the expected generic combination of dictyospores and eutypoid (or diatrypoid) stromata. The fulfilled predictions are the indicators of the natural system and of the robustness of its theoretical grounds.



Azbukinia ferruginea: Stroma and ascus with ascospores.



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TWO NEW SPECIES IN PARMELIACEAE (LICHENIZED ASCOMYCOTINA) AND NEW RECORDS FOR ARGENTINA

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ABSTRACT: The Argentinian species Punctelia jujensis Adler and Parmotrema pseudobreviciliatum Adler, Elix & Hale, are described as new. The former is known only from Jujuy Province and the latter, from Buenos Aires Province in Argentina, and also from Brazil. In addition four new species previously unrecorded for Argentina are reported.

METHODS: Thalline chemistry was determined by thin layer chromatography (Culberson & Ammann, 1979), high performance liquid chromatography (Lumbsch & Elix, 1985) and comparison with authentic samples.

PUNCTELIA JUJENSIS Adler sp. nov. Fig.1

Thallus foliaceus adnatus, cinereus, ca 10 cm latus, sine propagulis; lobis subrotundatis 3-7 mm latis. Superficies pseudocyphellatus, pseudocyphellis punctiformibus minutis (< 0.2 mm latis) sparsis. Facies infera castanea vel nigricans, rhizinis longis, simplicibus, eborineis vel hyalinis, raro concoloribus. Pycnidia inmersa, conidiis filiformibus, 9-15 µm longis. Apothecia ignota. Atranorinum et acidum gyrophoricum continens.

Type: **Argentina**, Jujuy Province, Yala River (65°25'W, 24°07'S,1500m); on roadside Populus sp. cortex, M.T.Adler, II-1986, BAFC 35.388-holotype, ANUC-isotype.

Thallus foliose, adnate, corticolous, light to dark grey, with chestnut to yellow tinge. Lobes apically subrotund, 3-7 mm wide. Upper surface plane to broadly undulate, rugose in the center, with punctiform, sparse, minute (< 0.2 mm diam.), evenly scattered pseudocyphellae; without isidia, soredia, squamules or lobulae. Medulla white. Lower surface chestnut to black except for an ivory marginal zone below the apices of the lobes. Rhizines long, simple, ivory, hyaline or concolorous with the lower surface. Pycnidia immersed, mainly submarginal, with filiform conidia 9-15µm long. Apothecia not known.
Chemistry: Cortex K+ yellow (atranorin), medulla K-, C+ pink and KC+ pink (gyrophoric acid).

Currently seven species of *Punctelia* with filiform conidia have been recognized, five of which lack vegetative propagules. Krog(1982) accepted three of the five such species: *P. hypoleucites* (Nyl.) Krog (pale underside, lecanoric acid); *P. microsticta* (Müll. Arg.) Krog (black underside, unknown fatty acids, spores less than 20 µm long); and *P. negata* (Nyl.) Krog (black underside, unknown fatty acids, spores more than 20 µm long). More recently Galloway and Elix (1984) added *P. subalbicans* (Stirt.) Galloway & Elix (pale underside, lecanoric acid as in *P. hypoleucites*, but differing mainly in distribution of pseudocyphellae; laminal in *P. hypoleucites*, marginal in *P. subalbicans*). Recently Elix and Johnston (1988) described also *P. nebulata*, which has pale underside and lacks medullary substances.

Two further species have vegetative diaspores: *P. colombiana* Sér. (Sérusiaux, 1984; isidiate, black underside, gyrophoric acid); and *P. novozelandica* Elix & Johnston (1988); lobulate and isidiate, black underside, lecanoric acid).

The new species, *P. jujensis*, belongs to the first group which lack vegetative propagules. It is distinguished by the presence of gyrophoric acid in the medulla in combination with a chestnut to black lower surface. This new species probably represents the non-isidiate morph of *P. colombiana*. This species is reported here for the first time from Argentina (see further). It was frequently collected on rocks of Buenos Aires, Córdoba and Jujuy Provinces.

PARMOTREMA PSEUDOBREVICILIATUM Adler, Elix & Hale sp.nov. Fig.2

Species cum thallo et substantiis principalibus (atranorinum et acidum alectoronicum) ut in *Parmotrema breviciliatum* (Hale) Hale sed ab hac specie conidiis filiformibus 8-11 µm longis differt.

Type: **Argentina**, Buenos Aires Province, on granite rock, near Cerro "El Centinela", Partido de Tandil (59°09'W, 37°20'S, 350 m). M.T.Adler I-1987; BAFC 35.901-holotype; ANUC, US-isotypes.

Thallus saxicolous, grey to greenish grey, ca 5-15 cm diam. or mat-forming. Lobes 4-10 mm wide, with rounded apices, sometimes crenate or deeply incised, especially towards the center, where they sometimes form isidioid (cylindrical to triangular, 1-3 mm wide) lobules (not present in all specimens); margin moderately ciliate with slender cilia up to 2.5 mm long. Upper surface broadly undulate, emaculate or slightly maculate in older parts, occassionally forming verrucose isidia-like granules. Medulla white. Lower surface black with a pale tan marginal zone at the apices of the lobes; this marginal zone is ivory, white or mottled when the lobes are fertile. Mature apothecia infrequent, cupuliform, stipitate, with an imperforate brown disc up to 1 cm diam.; margin ornate with isidioid lobules; ascospores 10-14 X 13-18 µm. Pycnidia immersed, conidia filiform 8-11 µm long.
hemistry: Cortex K+ yellow (atranorin); medulla K-, C-, KC+ purple turning orange; alectoronic acid (major),α-collatolic acid (major), unknown substance related to alectoronic acid (minor) and a unknown

pink pigment (variable from major to trace).

Parmotrema pseudobreviciliatum appears to be closely related to *P. breviciliatum* (Hale) Hale (1965 and 1974; holotype at US!). Both are saxicolous, similar in morphology and chemistry and occasionally form laminal, isidia-like structures. Nevertheless the two species differ in type and length of conidia: in *P.breviciliatum* they are sublageniform and 6-8 μm long while in *P.pseudobreviciliatum* they are slender, filiform and 8-11 μm long.

P. pseudobreviciliatum is also closely related to the corticolous Indian endemic *Parmotrema vartakii* Hale, which lacks both α-collatolic acid and the unknown associated with alectoronic acid, which are major and minor substances respectively in *P. pseudobreviciliatum*.

So far this new species is known from Argentina, where it grows on rocks both in protected sites (near small streams) and in more exposed situations, and from Brazil (Hale, pers. comunication).

Specimens examined: **Argentina.** Buenos Aires Province; on rock, near Arroyo "Los Helechos", Sierra de La Ventana, Partido de Tornquist, M.T.Adler, V-1986 (BAFC 35.787); on granite, near Cerro "El Centinela", Partido de Tandil, M.T.Adler, I-1987 (BAFC 35.935, 35.938); on granite, near "La Cascada", Partido de Tandil, M.T.Adler, I-1987 (BAFC 35.933, 35.934, 35.936, 35.942).

NEW RECORDS FOR ARGENTINA

Flavoparmelia haysomii (Gyel. & Fóriss) Hale

Buenos Aires Province. Olavarría, Partido de Olavarría, on rock, mixed with *Flavoparmelia papillosa*, M.T. Adler, III-1986 (BAFC 35.695). Sierra de La Ventana, Partido de Tornquist, Parque Provincial E. Tornquist, on rock mixed with *F. papillosa*, M.T. Adler, V-1986 (BAFC 35.699).

Paraparmelia rupicola (Lynge) Elix & Johnston

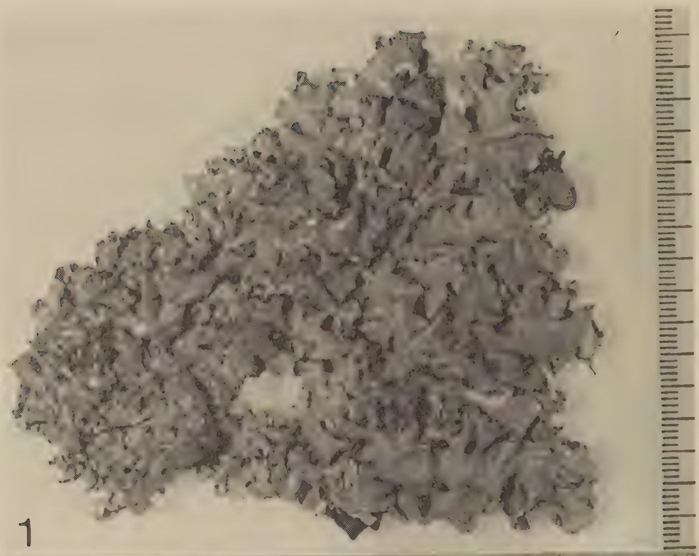
Buenos Aires Province. Sierra de La Ventana, on rock, M.T.Adler V-1986 (BAFC 35.795); Tandil, near Cerro "El Centinela", on rock, M.T. Adler, I-1987 (BAFC 36.012); Tandil, "La Cascada", on rock, M.T. Adler I-1987 (BAFC 36.009, 36.010, 36.011).

Punctelia colombiana Sérusiaux

Buenos Aires Province. Sierra de La Ventana, Arroyo "Los Helechos", on rock, M.T. Adler, V-1986 (BAFC 35.801, 35.802); Tandil, "La Cascada", on rocks, M.T. Adler, I-1987 (BAFC 36.393, 35.915); Tandil, "La Movediza", on rock, M.T. Adler, I-1987 (BAFC 35.919).

Córdoba Province. Near Copina, on soil deposited on rocks, M.T.Adler, X-1985 (BAFC 36.396); Los Gigantes, on soil deposited on rocks, M.T. Adler, X-1985 (BAFC 36.395).

Jujuy Province. Near Laguna Yala, on soil deposited on rocks, M.T. Adler, II-1986 (BAFC 36.397, 36.398, 36.400, 36.401); near Laguna Yala, on *Alnus jorulensis* cortex, M.T. Adler, II-1986 (BAFC



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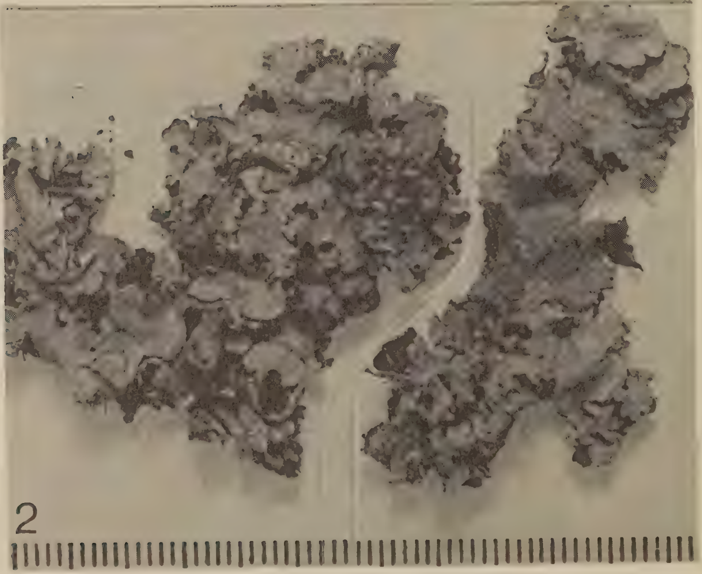

2

Fig.1- Holotype of Punctelia jujensis (BAFC 36.388).

Fig.2- Part of holotype of Parmotrema pseudobreviciliatum (BAFC 35.936).

36.402).

Some collections from Jujuy Province, show a typical mixture of both coralloid and small dorsiventral isidia (as in the type at S!). However most collections, especially from Córdoba and Buenos Aires Provinces, have only the small, simple isidia.

Punctelia semansiana (Culb. & Culb.) Krog

Buenos Aires Province. Sierra de La Ventana, Abra de La Ventana at Cerro Bahía Blanca's base, on soil and musci, M.T. Adler, V-1986 (BAFC 35.805 (determination, M.T. Adler, confirmed by J.A. Elix), 35.808); Tandil, "La Movediza", on rock, M.T. Adler, I-1987 (BAFC 35.910, 35.914); Tandil, "La Cascada", on rocks, M.T. Adler, I-1987 (BAFC 35.911, 35.912, 35.913).

Salta Province. Cuesta del Obispo, near Escoipe, part on soil and musci and part on rock, M.T. Adler, II-1986 (BAFC 35.945, det. by M.T. Adler, confirmation, J.A. Elix).

Part of the Argentinian collections studied had the lobes more incised than the holotype (at DUKE!), sometimes plenty of lobules.

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SOME NAME CHANGES NECESSITATED BY THE REDEFINITION OF THE GENUS CANDIDA

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In a recent publication Weijman *et al.* (1988) further amended the description of the genus *Candida* and removed some basidiomycetous species to the genera *Rhodotorula* and *Cryptococcus*. However they did not completely purge *Candida* of all its basidiomycetous species, i.e. all those which give a positive result in the diazonium blue B and urea tests, have a fine structure characteristic of basidiomycetous yeasts and whose polysaccharides contain either xylose, fucose or rhamnose.

Four species were overlooked, namely: *Candida buffonii, C. dulciaminis, C. lignophila,* and *C. huempii.* Moreover, although Weijman *et al.* (1988) placed *Apiotrichum* in synonymy with *Cryptococcus* they failed to rename the species *A. futronensis* and *A. nothofagi.* The purpose of this short communication is to remedy these ommissions.

The diagnostic properties of *Cryptococcus* and *Rhodotorula* according to Weijman *et al.* (1988) are given in Table 1, together with results for inositol growth, galacturonate growth, and starch production reported by Barnett *et al.* (1987, 1989), as well as of the polysaccharide analyses found in this study. The carbohydrates were analyzed according to Weijman & Golubev (1987). The cell walls are multilayered and therefore characteristic of basidiomycetous yeasts (W. Batenburg-v.d. Vegte, pers.comm.).

Table 1

	Growth		Starch	Polysaccharide		
	inositol	galacturonate	production	xylose	fucose	rhamnose
Cryptococcus	+ or -	+	+	+	+ or -	-
Rhodotorula	-	+ or -	-	-	+ or -	+ or -
Candida buffonii (CBS 7150)	-	-	-	-	+	+
C. dulciaminis (CBS 7288)	-	+	-	-	+	+
C. huempii (CBS 8186)	-	+	+	+	+	-
C. lignophila (CBS 7109)	-	+	-	-	+	+
Apiotrichum futronensis (CBS 8163)	-	-	-	-	+	+
A. nothofagi (CBS 8166)	-	-	-	-	+	+

From this table it can be clearly seen that *Candida huempii* must be reassigned to *Cryptococcus* and the rest of the species to *Rhodotorula*, as follows:

Cryptococcus huempii (Ramírez & González) Roeijmans, van Eijk & Yarrow nov. comb.

Basionym: *Candida huempii* Ramírez & González, 1984, Mycopathologia 88: 167.

Rhodotorula buffonii (Ramírez) Roeijmans, van Eijk & Yarrow nov. comb.

Basionym: *Torulopsis buffonii* Ramírez, 1957, Microbiol. Españ. 10: 238.

Rhodotorula dulciaminis (Tokuoka et al.) Roeijmans, van Eijk & Yarrow nov. comb.

Basionym: *Candida dulciaminis* Tokuoka, Ishitani, Goto & Komagata, 1987, J. Gen. Appl. Microbiol. 33: 5.

Rhodotorula lignophila (Dill *et al.*) Roeijmans, van Eijk & Yarrow nov. comb.

Basionym: *Candida lignophila* Dill, Ramírez & González. 1984, Antonie van Leeuwenhoek 50: 220.

Rhodotorula futronensis (Ramírez & González) Roeijmans, van Eijk & Yarrow nov. comb.

Basionym: *Apiotrichum futronensis* Ramírez & González, 1984, Mycopathologia 88: 74.

Rhodotorula nothofagi (Ramírez & González) Roeijmans, van Eijk & Yarrow nov. comb.

Basionym: *Apiotrichum nothofagi* Ramírez & González, 1984, Mycopathologia 88: 76.

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A CONTRIBUTION TO THE GENERIC DEFINITION OF FUSARIUM

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Abstract

In *Fusarium* distinction is usually made between macroconidia and microconidia, though a differentiation between conidia of the aerial mycelium and sporodochial conidia (always pluricellular and foot-celled) is more appropriate. Classification of the microconidial or aerial forms of sporulation is possible in *Fusarium* if the generic diagnosis is slightly broadened, while none of the other presently used amerosporous genera is suited to accommodate them.

A polythetic definition of the genus is proposed that takes care of numerous variations. The crucial point is the potential of every *Fusarium* to produce fusiform, septate, "sporodochial" phialoconidia, though they need not be present in every specimen or culture. With this definition it is possible to recognize isolates that form exclusively microconidia as *Fusarium* and it is also admissible to combine taxa based on such conidia in *Fusarium.*

Hennebert (1987) outlined the problems involved in the definition and naming of pleoanamorphic genera in either a pseudobotanical or an anatomical way. He reached the conclusion that what is used in practice is some kind of compromise between the two; it is impossible to state in general rules, to what extent the anatomical system can be pursued.

Fusarium with its different forms of sporulation is an outstanding example to illustrate all the inherent problems. An unmistakable definition of the genus, covering all border-line cases, is one of the major tasks of the I.S.P.P. Committee for *Fusarium* nomenclature. Only with such a definition will it be possible to avoid further conflicts about the nomenclature of microconidial forms, which still hamper the communication among experts.

Among all hyphomycete genera, *Fusarium* is one of the best known and extensively studied cases, with regard to natural affinities of sections and teleomorph connections (Samson & Gams, 1984). Since Wollenweber and Reinking (1935) the genus has a rather natural circumscription. Gams & Gerlagh (1968), included the anamorph of *Plectosphaerella* that does not really fit in this complex of related fungi and will have to be excluded. Among previously reported teleomorphs, *Calonectria* has been eliminated with the conclusion by Rossman (1983), that *C. rigidiuscula* is best classified as *Nectria rigidiuscula* Berk. & Br.. The genera *Micronectriella*, *Cryphosphaeria* and other teleomorph names (ultimately *Monographella*, Müller, 1977) have been discarded for *Fusarium* by the now widely accepted conclusion that *F. nivale* with its annellidic conidiogenesis (Gams & Müller, 1980) is to be accommodated in *Microdochium* (or *Gerlachia*), because of the classification of the teleomorph in the Hyponectriaceae (Samuels & Hallett, 1983). Other species transferred by von Arx (1984) from *Fusarium* to *Microdochium* may better remain in *Fusarium*, as their conidiogenesis is regularly phialidic. The genus *Fusarium* then will contain only anamorphs of two complex ascomycete genera of the Nectriaceae, *Gibberella* and *Nectria*.

This situation provides strong arguments for the desirability to reach a delimitation of the genus according to natural affinities rather than according to a schematic anatomical criterion of conidial shape and conidiogenesis. The salient feature of the genus is septate, fusiform, pedicellate macroconidia with phialidic (monophialidic or sympodial-polyphialidic) conidiogenesis, but other forms of conidia and modes of conidiogenesis also occur. The occurrence of sporodochia, for some time used to distinguish *Fusarium* from *Fusisporium* Link, had been obsolete as a generic criterion since Wollenweber's work (Wollenweber and Reinking, 1935), but see below.

According to the present circumscription, the genus also comprises species that form non-septate and 1- to 2-septate **microconidia**. Since the division of conidia into pluriseptate macroconidia and microconidia is usually not possible along a sharp borderline, it might be more precise to distinguish between conidia (non-pedicellate) borne in the aerial mycelium on non-aggregated conidiophores ("**conidia of the aerial mycelium**") and of conidia borne on the surface of the substrate on aggregated conidiophores: pionnotes, sporodochia, synnemata, acervuli ("**sporodochial conidia**"). The latter are pedicellate and are consistently of phialidic origin; the former may have both phialidic and polyphialidic conidiogenesis (Booth, 1971). When these conidia are produced singly, Booth (l.c.) called them polyblastic, Gams (1973) preferred to speak of phialides with solitary conidia rather than true blastoconidia, because after formation of a single conidium an internal wall thickening becomes visible that occludes the opening of the conidiogenous cell. If this hypothesis is true, there is no conceptual discontinuity between the phialidic and monoconidial conidiogenesis (at least in *Fusarium*). Electron-microscopic examination of the situation has still to be done. For brevity's sake, we shall continue to call them polyblastic here. But the same fungi under certain circumstances also produce phialidic (sporodochial) conidia and then there is no doubt about their inclusion in *Fusarium*. In culture, wild-type isolates of *Fusarium* always produce phialidic pedicellate conidia under certain conditions. The only species that fail to do so are *F. camptoceras* and *F. ventricosum* and their inclusion in the genus remains problematic. In the Berlin collection there are only two isolates of each species and possibly, if the conditions are varied, they also may form sporodochia.

Matsushima (1971) defined the genus *Pseudofusarium* because of polyblastically formed conidia, but in 1980 he no longer recognized this genus as distinct from *Fusarium*. We agree with this conclusion. *F. semitectum* (now *F. pallidoroseum* (Cooke) Saccardo, fide Booth & Sutton, 1984), forms, by preference, fusiform conidia on polyblastic conidiogenous cells in the aerial mycelium and it has therefore repeatedly caused problems of generic classification. But under special conditions it also produces typical *Fusarium* conidia in culture, establishing its classification in this genus. Within the same species there are isolates (also in *F. poae* and others) which prefer to produce conidia in the aerial mycelium only, and others which produce the sporodochial conidia readily.

It is very necessary to use the morphology of the aerial conidia and their conidiophores to identify many *Fusarium* species.

-- If only sporodochial conidia of *F. tricinctum* are available, it is not certain whether this is *F. tricinctum* or *F. reticulatum* or *F. acuminatum*.

-- No species of the section *Liseola* can be identified if aerial conidia are absent.

are absent.
-- One important difference between sections *Elegans* and *Martiella* is the length of the conidiophores of the aerial mycelium: short in *Elegans*, and long in *Martiella.*

The crucial question to be asked here is, whether it is necessary and meaningful to coin additional generic names for these synanamorphs present alongside the septate, phialidic, sporodochial conidia. If a choice for the anatomical system sensu Hennebert is made, a complicated nomenclature will ensue, such as "*Pseudofusarium* synanamorph of *F. chlamydosporum*", etc. Some new generic names will have to be coined, because *Cephalosporium* (even in its broadest sense) is no longer available and the microconidial forms of sporulation of the *Eupionnotes, Spicarioides, Sporotrichiella, Liseola, Martiella* and *Elegans* fusaria definitely do not belong to *Acremonium* as circumscribed by Gams (1971). Admittedly, the circumscription of *Acremonium* is still very heterogeneous and far from ideal, but a further extension to include microconidial fusaria would only make matters worse. Moreover, for the pluriseptate conidia of the aerial mycelium (sections *Roseum* and *Arthrosporiella; F. bullatum, F. stilboides* and *F. sporotrichioides*), the genus *Fusisporium* would have to be reintroduced, and also the species *Fusarium ventricosum*, which Wollenweber and Reinking (1935) placed in *Fusarium* because of its teleomorph, would have to be called *Fusisporium ventricosum*, a step backward to a pre-Wollenweber system.

The alternative is to reach a polythetic definition of *Fusarium*, that may be rather complex and worded like "...if only microconidia occur, then ...". Nevertheless, a reasonably experienced worker should be able to recognize an atypically developed *Fusarium* as such, as long as there is positive evidence that no other similar anamorph can be confused with it. Gams (1982, 1984) argued in particular for uniting synanamorphs of one fungus with the same conidiogenesis in the same genus whenever possible. Minter (1987) expressed a similar idea: "The plastic nature of fungal development makes it essential that conidiogenesis is not studied separately: it can only be understood in the context of the whole fungus". Conidial septation is now often considered dissatisfactory as a generic criterion and 0- to 3-septate species are recognized in, e.g., *Arthrobotrys* (Schenck et al., 1977; van Oorschot, 1985). In some *Fusarium* species there is a continuous range from 1-celled to 4- or more-celled conidia; in others the delimitation between macro- and microconidia is sharper.

The best way to reach a meaningful decision between the two alternatives, anatomical or botanical nomenclature, that will be acceptable to the *Fusarium* experts, is to analyze some cases. We discuss here two examples that may point to the direction of the anatomical system:

Seemüller (1968) was not prepared to accept a microconidial fungus as a *Fusarium* of the section *Sporotrichiella* unless it produced at least some macroconidia. But we often identify *Fusarium* species of the *Sporotrichiella* section on the basis of the microconidia alone (especially *F. poae* and *F. tricinctum*). Problems may arise with *F. sporotrichioides* and *F. chlamydosporum*, but actually the "macroconidia" are not indispensable. In both cases the chlamydospores are important (otherwise confusion with *Microdochium* or similar fungi might be possible), and in *F. sporotrichioides* also the conidiophores, on which the pyriform conidia are borne.

In the sections *Elegans* and *Liseola* often specimens or isolates are found that exclusively contain microconidia. As mentioned above, no adequate generic name is available to cover the microconidia. It is, however, possible to recognize such fungi in their true identity. Admittedly, Gams (1971) made a mistake in this respect in overlooking the identity of *Cephalosporium indicum* Petch with *F. moniliforme*. This error was corrected by Nirenberg (1976). But what we wish to emphasize is that there are hardly any fungi known that can be confused with exclusively microconidial *Elegans* or *Liseola* fusaria. Therefore we plead again for recognizing these exclusively microconidial cases as *Fusarium* and nothing else. Otherwise, if the anatomical system were binding, a microconidial specimen of *Fusarium moniliforme*, for example, would always have to be referred to as *Verticillium* (or *Paecilomyces*?) *verticillioides* synanam. of *F. moniliforme*. We do not see any advantage in this.

A crucial deliberation for the present case is the following: the level of species is the basic element of biological classification. In the philosophy of taxonomy the species are regarded as the "individuals" (Ghiselin, 1974; Hull, 1976) which do not have properties that define them (unlike all higher taxonomic categories, called "classes" in this philosophical approach); they simply exist. Therefore a type specimen of a species represents the species in question, no matter how small and fragmentary it is. It is impossible to postulate any criteria to which a type must suffice in order to be recognized as such. This is of course the basic philosophy of the botanical system, as it is applied in the nomenclature of fungal teleomorphs. The anatomical system for anamorphs and synanamorphs is a concession to practical needs; additional names for anamorphs and synanamorphs are permitted but by no means imposed by Article 59 of the ICBN. It must not become a dogma for its own sake that hampers taxonomic insight. Even if we adopt the anatomical idea (not the principle), we must ask the question: to what extent must we dissect morphs?

The only criterion to apply in *Fusarium* is that the type of a species must contain a *Fusarium* and not a fungus of another genus. This depends on the breadth of the generic definition.

Therefore a **polythetic generic definition** is offered here that takes into account all marginal cases. It may read approximately as follows:

Colonies growing moderately (3-5 cm diam in 1 week at 20°C) to rather fast (6-10 cm diam), consisting of hyaline or brightly coloured vegetative hyphae $> 1.5\,\mu$m wide; aerial mycelium, if present, of characteristic floccose felty appearance. Pigmentation ranging from white to pale pink to intensely red, orange, purple, blue or blue-green, and seldom olive-green or brown, particularly in colony reverse (but never with olivaceous-brown or black wall pigments in the submerged hyphae). Hyaline or bright-coloured to brownish chlamydospores often produced in terminal, lateral or intercalary position, in the latter case often forming chains; conidial cells may also become transformed into chlamydospores. Sclerotial bodies of irregular shape, beige, ochre, brown or blackish, occurring in some species. Sporulation scattered in the aerial mycelium or aggregated in synnemata, sporodochia (sometimes appearing acervular on the host, Sutton, 1986) or forming extended slimy masses (pionnotes). Their conidiophores are complex branched structures, ending in numerous, more or less cylindrical or slightly tapering phialides. They bear fusiform, more or less curved conidia, which are none- to pluriseptate, with a tapering, more or less pointed apical cell, and a more or less differentiated (foot-shaped, see Sutton 1986) basal cell. Conidiophores of the aerial mycelium are far less complex, sometimes consisting of a single conidiogenous cell only (sect. *Elegans*), sometimes consisting of a supporting cell besides the conidiogenous cell (sections *Sporotrichiella* p.p., *Eupionnotes,* and *Martiella* p.p.), sometimes with branching or proliferating supporting cells (sections *Liseola, Spicarioides, Roseum, Martiella* p.p., *Arthrosporiella,* and *Sporotrichiella* p.p.; *F. stilboides*), seldom differentiated by verticillate (sections *Martiella* p.p. and *Liseola* p.p.) or somewhat penicillate (*F. decemcellulare*) arrangement, or polyphialidic (several conidia arising from each denticle) or exclusively polyblastic (one conidium formed from each denticle) conidiogenesis (*F. chlamydosporum, F. pallidoroseum, F. camptoceras*). They bear either mostly one-celled, smaller conidia (microconidia), similar in width to the macroconidia, mostly ellipsoidal, slightly curved, sometimes also fusiform, clavate, pyriform or subglobose, with a rounded or truncate base, normally formed in slimy heads, in a few species also in basipetal chains, or fusiform pluriseptate conidia (macroconidia) without a foot-shaped basal cell.

The crucial point in this definition is the **potential** of every *Fusarium* to produce fusiform, septate "sporodochial" (in the broadest sense, see above) phialoconidia. But they need not be present in every specimen or culture.

If in some isolates conidia occur exclusively in the aerial mycelium, they can be recognized as *Fusarium* by the following combinations of characteristics:

-- Conidia fusiform, mostly 1-celled, borne on densely sympodially proliferating conidiogenous cells (polyblastic); intercalary chlamydospores abundant
  -- colonies intensely red *F. chlamydosporum* var. *chlamydosporum*
  -- colonies beige to brown *F. chlamydosporum* var. *fuscum*

-- Conidia ellipsoidal, mostly 1-celled, more or less curved, sometimes pyriform ones present, borne on mostly unbranched, short conidiophores; colonies beige to pink to violet; terminal, lateral or intercalary chlamydospores present sect. *Elegans*
-- Conidia ellipsoidal, in some species 1-celled, in others 1-4-celled, borne on unbranched or branched long conidiophores; colonies beige, pink to vinaceous or blue; terminal, lateral or intercalary chlamydospores present sect. *Martiella*

-- Conidia clavate, elongate-ovoid or pyriform, mostly 1-celled, borne on more or less branched conidiophores in slimy heads or chains; colonies beige, pink to pale purple or vinaceous; chlamydospores absent sect. *Liseola*

-- Conidia napiform, mostly 1-celled, borne on sparsely branched conidiophores with inflated phialides; chlamydospores absent *F. poae*

-- Conidia citriform, mostly 1-celled, borne on sparsely branched conidiophores with slender cylindric phialides; true chlamydospores absent *F. tricinctum*

-- Conidia fusiform, septate, borne on branched conidiophores with polyblastic conidiogenous cells
  -- Colonies beige to brown; conidia 1- to mostly 3-septate, almost straight; chlamydospores present or absent *F. pallidoroseum* var. *pallidoroseum*
  -- Colonies beige to brown or olivaceous-brown; conidia 1- to mostly 5-septate, almost straight; chlamydospores present or absent *F. pallidoroseum* var. *majus*
  -- Colonies beige to brown; conidia mostly 5-septate, slightly curved; chlamydospores absent *F. camptoceras*
  -- Colonies beige to cherry red, conidia 1- to 5-septate, almost straight; chlamydospores absent *F. avenaceum*
  -- As above, pyriform conidia also occurring *F. arthrosporioides*

-- Conidia fusiform, mostly 1-3-septate, borne on proliferating long conidiophores; colonies white, isabelline to beige; chlamydospores terminal or intercalary *F. ventricosum*

With this refined generic definition it will be possible to assign atypically developed isolates to the correct genus. It will also be possible to recognize type specimens that exclusively contain microconidia as representing species of *Fusarium* (provided a confusion with fungi outside the genus can be ruled out). Only if it is impossible to decide about the specific identity of a certain protologue and type specimen can a name be declared as doubtful.

Many fusaria can only be identified correctly in culture, if and where they are able to produce all their morphological characteristics ("Hochkultur" of the wild type), such as aerial mycelium with conidiophores and conidia, large conidia produced on aggregated conidiophores, and chlamydospores. Growth patterns, colour and sclerotial bodies give only hints. Faced with the problem of identifying a *Fusarium* to species, if we had the choice to do it either on the basis of the aerial conidiophores and conidia only, or on the "macroconidia" only, we would choose the first option; it generally is safer.

The present definition may thus serve to settle debates concerning the nomenclature in the section *Liseola* (Nirenberg, 1976; versus Neish & Leggett, 1981; Kuhlman, 1982), where the oldest available names of three recognized species are based on microconidial material.

F. verticillioides - *Oospora verticillioides* Sacc.
F. sacchari - *Cephalosporium sacchari* Butler
F. proliferatum - *Cephalosporium proliferatum* Matsushima

The advantages of accepting these names based on microconidial material for *Liseola* fusaria have been emphasized by Nirenberg (1976) and Gams (1982, 1984). If *F. sacchari* is not recognized for the taxon under consideration, then this fungus can certainly not be called *F. subglutinans* (Nelson et al., 1983), because at least one other included name is older at specific rank: *F. neoceras* Wollenw. & Reinking.

In this text related genera, particularly *Cylindrocarpon*, have not been touched, but similar problems apply to them.

We hope to have shown here that the acceptance of microconidial forms in *Fusarium* and the recognition of microconidial type specimens for species of *Fusarium* are in line with current *Fusarium* taxonomy and contribute to a natural delimitation of the genus; they are acceptable according to the rules of nomenclature and contribute to the clarification of some nomenclatural problems.

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CHECKLIST OF WESTERN AUSTRALIAN LICHENS

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ABSTRACT : A checklist of 380 lichen species and 16 infra-species taxa has been compiled from an examination of specimens and herbarium records in Australia, British Museum (Natural History) London , and the Conservatoire et Jardin Botaniques (Geneva). Nine genera requiring taxonomic studies are included without species listings.

Introduction

The earliest collection of lichens from Western Australia was made by Robert Brown in 1801 when he was botanist aboard the "Investigator". Collections were made on the mainland adjacent to the Great Australian Bight. Although a list of lichens was published as an appendix to Flinder's journal "Voyage to Terra Australis", their exact localities remain vague.

In 1817, Charles Gaudichaud-Beaupré accompanying Admiral Henri Louis Freycinet on the "L'Uranie" arrived in Shark Bay on September 12, 1818 (Bassett 1962). From the entrance to Shark Bay they moved 40 miles or so across the water to Dampier Bay and the "L'Uranie" laid anchor on September 13. The Bay formed the head of the Peron Peninsula and harboured hostile aborigines, so much so, that when Gaudichaud called for travelling companions to embark on a short plant collecting trip, he had to go botanizing alone. The lichen collections, on return to France, were determined by Christian Hendrik Persoon and the Shark Bay specimen was identified as *Lecidea ochroleuca* Pers.

With the establishment of the Swan River Colony in 1829, botanical exploration expanded and collections made in the hinterland. All previous collections had been along the coastline. With the growth of the settlement, a greater interest in the country was developed in England and Europe, which resulted in European botanists visiting the country for the purpose of investigating the flora and introducing its plants into cultivation.

In 1838, the German botanist Ludwig Preiss visited the Colony and remained until 1842. During this period, Preiss collected thoroughly around Perth, Fremantle, Rottnest Island, Geographe Bay, Busselton, King George's Sound and Cape Riche. He explored the country as far as Cunderdin in the district known as "Quangen Plains". On his return to Germany, the lichen collections were identified by Elias Fries who published an account in "Plantae Preissianae sive enumeratio plantarum" Volume 2. Of the 23 lichens identified, *Usnea pulvinata* Fr. and *Cladonia scutellata* Fr. were described as new. The latter species was collected "ad caudicem Macrozamia preissii". It is now correctly named as *Thysanothecium scutellatum* (Fr.)D.Galloway.

At about the time Preiss was collecting in Western Australia, one of the early settlers, James Drummond made large collections and botanically investigated until then, unknown country. Correspondence with Sir William Hooker added to Drummond's interest and he published several plant names in the Kew Journal (Erickson 1969). Unlike Preiss, who he accompanied for a time, Drummond was not particular as to the collecting localities of his plants, contenting with the note "Swan River". This may be taken to represent the country between the south coast and the Victoria district, including east Mount Barren and the Murchison. In addition to his letters to Sir William Hooker, Drummond contributed several interesting articles to the local newspaper containing systematic, ecological and economic references. Although Drummond was unimpressed with the Porongurup Range near Albany for collecting phanerogams, he was enthusiatic about the cryptogams of the region. This is recorded in a letter to Mr. G. Leake published in "The Inquirer" dated December 6, 1848.

> " The Perangarup (sic) are clothed with mosses and jangermannia (sic) and lichens as rank and luxuraint as I have seen in the moist, rich valleys in the south of Ireland."

Although principally concerned with flowering plants, Drummond had a keen eye for lichens. An observation made on a lichen now correctly known as *Cladia ferdinandii* occurs in a letter to the editor of "The Inquirer" published on May 11, 1842.

> " The beautiful lichen nearly allied to the reindeer moss, with a stem perforated like lace, grows near to Halfway House on the York road."

In 1867, Ferdinand von Müller visited Western Australia on invitation of the Government. He did not contribute much to the State as a collector, but did stimulate in the people he met an interest in the Australian flora, and encouraged private collections among the early settlers. Few of these settlers collected lichens for Ferdinand von Müller.

The desert regions were explored by Ernest Giles and important collections were also made by Richard Helms on the Elder Expedition. The specimens were forwarded to Ferdinand von Müller and in turn the lichens forwarded to Jean Müller in Geneva. The identifications were published in the journal Hedwigia in 1892.

The late P. Bibby of the National Herbarium, Victoria was the first person in Australia to conduct critical taxonomic research on lichens and hepatics. Gordon Smith, then lecturer in Botany at the University of Western Australia, collected lichens and curated the collections in the Botany Department Herbarium (UWA). In 1955, they collaborated on a paper compiling a list of 17 species for Western Australia. However, the authors did emphasize that the list was not comprehensive for the State. Later, Smith (1962), made a study of the flora of the granite outcrops in the Porogurups and listed 12 lichens for that area. E.R.L. Johnson and A.M.Baird (1970) of the same Department studied the vegetation at Forrest on the Nullabor Plain in 1930 and 1955. From their collections, 12 lichens were identified by Dr. R.W.Rogers.

Following Bibby's death, Rex Filson actively continued taxonomic work on lichens and identified Western Australian specimens. Research on coastal limestone lichens was conducted by Sammy (1970) and together with Smith 13 species were recorded for this specialised habitat near Perth (Sammy and Smith 1972). During 1982, R.M. and D.H.S. Richardson collected and partly identified 194 species of lichens from Western Australia. This collection, together with the personal herbarium of N.Sammy, forms the foundation of the lichen specimens at the Western Australian Herbarium (PERTH).

Checklist for Lichen Flora

In the checklist, the lichen genera and species are listed alphabetically. Where the type specimen has been described from Western Australia, the name is shown in bold print. Genera inlcuded without species listing indicate the requirement for taxonomic studies to be undertaken.

Acarospora cervina (Ach.)Mass
Acarospora citrina (Taylor)Zahlbr. & Rech.
Acarospora ferdinandii (Müll.Arg.)Hue
Acarospora negligens H.Magn.
Acarospora novaehollandiae H.Magn.
Acarospora sinopica (Wahlenb.)Mass.
Anema
Arthonia
Arthopyrenia lapponica Anzi
Arthothelium interveniens (Nyl.)Müll.Arg.
Aspicilia calcarea (L.)Mudd
Aspicilia calcarea (L.)Mudd var. caesioalba (le Prev.)Hazsl.
Blastenia
Bacidia microphyllina (Tuck.)Riddle
Bacidia aff. subuletorum (Schreb.)Lett.
Buellia cretacea Müll.Arg.
Buellia desertorum Müll.Arg.
Buellia disciformis (Fr.)Mudd
Buellia epigaea (Hoffm.)Tuck.
Buellia farinulenta Müll.Arg.
Buellia glomerulans (Müll.Arg.)Zahlbr.
Buellia inturgescens Müll.Arg.
Buellia marginulata (Müll.Arg.)Zahlbr.
Buellia punctata (Hoffm.)Mass.
Buellia retrovertens Tuck.
Buellia spuria (Schaerer)Anzi
Buellia stellulata (Taylor)Mudd.
Buellia stigmaea Tuck.
Buellia subalbula (Nyl.)Müll.Arg.
Buellia subcoronata (Müll.Arg.)Malme
Buellia subdisciformis (Leighton)Vainio
Calicium abietinum Pers.
Calicium glaucellum Ach.
Calicium robustellum Nyl.
Calicium salicinum Pers.
Calicium subquercinum Asah.
Calicium tricolor F.Wilson
Calicium victorianum (F.Wilson)Tibell ssp. victorianum
Calicium victorianum (F.Wilson)Tibell ssp. desidiosum Tibell
Caloplaca aurantiaca (Lightf.)Th.Fr.
Caloplaca cerina (Ehrh.)Th.Fr.
Caloplaca cinnabarina (Ach.)Zahlbr.
Caloplaca citrina (Hoffm.)Th.Fr.
Caloplaca erythrosticta (Taylor)Zahlbr.
Caloplaca ferruginea (Hudson)Th.Fr.
Caloplaca flavorubescens (Hudson)Laundon
Caloplaca granularis (Muell.Arg.)Zahlbr.
Caloplaca holocarpa (Hoffm.)Wade
Caloplaca irrubescens (Nyl.)Zahlbr.

Caloplaca lactea (Massal.)Zahlbr.
Caloplaca lateritia (Taylor)Zahlbr.
Caloplaca marina (Wedd.)Zahlbr.
Caloplaca murorum (Ach.)Th.Fr.
Caloplaca murorum var. areolata (Müll.Arg.)Zahlbr.
Caloplaca murorum var. miniata (Hoffm.)Th.Fr.
Caloplaca murorum var. obliterata (Pers.)Jatta
Caloplaca saxicola (Hoffm.)Nordin
Candelaria concolor (Dickson)J.Stein.
Candelaria spraguei (Tuck.)Zahlbr.
Candelaria xanthostigmoides (Müll.Arg.)R.W.Rogers
Candelariella antenaria Räs.
Candelariella vitellina (Ehrh.)Müll.Arg.
Candelariella xanthostigma (Ach.)Lettau
Canoparmelia macrospora Elix & Johnston
Canoparmelia pruinata (Müll.Arg.)Elix & Johnston
Catapyrenium compactum (Massal.)R.Sant.
Catapyrenium lachneum (Ach.) R.Sant.
Catillaria atropurpurea (Schaerer)Th.Fr.
Catillaria chalybeia (Borr.)Massal.
Catillaria lenticularis (Ach.)Th.Fr.
Chaenotheca brunneola (Ach.)Müll.Arg.
Chaenotheca carthusiae (Harm.)Lettau
Chaenotheca chrysocephala (Turn. ex Ach.)Th.Fr.
Chaenotheca ferruginea (Turn. ex Sm.)Migula
Chaenotheca melanophaea (Ach.)Zw.
Chaenothecopsis debilis (Turn. & Borr. ex Sm.)Tibell
Chaenothecopsis pusilla (Ach.)A.Schmidt
Chondropsis semiviridis (F.Müll. ex Nyl.)Nyl.
Chrysothrix candelaris (L.)Laudon
Cladia aggregata (Sw.)Nyl.
Cladia corallaizon F.Wilson ex R.Filson
Cladia ferdinandii (Müll.Arg.)R.Filson
Cladia schizopora (Nyl.)Nyl.
Cladia sullivanii (Müll.Arg.)Martin
Cladina confusa (R.Sant.)Follman & Ahti
Cladonia amaurocraea (Flörke)Schaerer
Cladonia angustata Nyl.
Cladonia borbonica (Delise)Nyl.
Cladonia capitata (Michaux)Sprengel
Cladonia capitellata (J.D.Hook &Tayl.)Church.Babingt.
Cladonia calyciformis Nuno
Cladonia carassensis Vainio
Cladonia cariosa (Ach.)Sprengel
Cladonia cervicornis (Vainio)Kernst.
Cladonia cervicornis subsp. verticillata (Hoffm.)Ahti
Cladonia chlorophaea (Flörke)Sprengel
Cladonia coniocraea (Flörke)Sprengel
Cladonia degenerans (Flörke)Sprengel
Cladonia enantia Nyl.
Cladonia fimbriata (L.)Fr.
Cladonia foliacea (Hudson)Schaerer
Cladonia foliacea var. firma (Nyl.)Vainio
Cladonia furcata (Hudson)Schrader
Cladonia krempelhuberi Vainio
Cladonia macilenta Hoffm.

Cladonia merochlorophaea Asah.
Cladonia ochrochlora Flörke
Cladonia pleurota (Flörke)Schaerer
Cladonia polydactyla (Flörke)Krempelh.
Cladonia praetermissa A.W.Archer
Cladonia phyllophora Hoffm.
Cladonia pyxidata (L.)Hoffm.
Cladonia ramulosa (With.)Laundon
Cladonai rigida (J.D.Hooker & Taylor) Hampe
Cladonia southlandica Martin
Cladonia subcervicornis (Vainio)Kernst.
Cladonia sulcata var. wilsonii (Archer)Archer
Cladonia tesellata Ahti & Kashiwadani
Cladonia theophila Asah.
Coccocarpia erythroxili (Sprengel)Swinscow & Krog
Coelocaulon aculeatum (Schreber)Gyel.
Collema coccophorum Tuck.
Collema glaucopthalmum Nyl.
Cyphelium trachylioides (Nyl.ex Deichm. Branth & Rostr.)Erichs. in Keissler
Degelia duplomarginata Arvidsson & Galloway
Diploicia canescens (Dickson)Massal
Diploschistes gypsaceus (Ach.)Zahlbr.
Diploschistes hensseniae Lumbsch & Elix
Diploschistes ocellatus (Vill.)Norm.
Diploschistes scruposus (Schreb.)Norm
Diplotomma alboatrum (Hoffm)Flotow
Dirinaria aegialita (Ach.)Moore
Dirinaria applanata (Fée)Awasthi
Dirinaria batavica Awasthi
Dirinaria picta (Sw.)Clem. & Schaerer
Endocarpon helmsianum Muell.Arg.
Ephebe lanata (L.)Vainio
Eremastrella crystallifera (Taylor)G.Schneider
Flavoparmelia diffractaica Elix & Johnston
Flavoparmelia proeuplecta Elix & Johnston
Flavoparmelia ferax (Müll.Arg.)Hale
Flavoparmelia rutidota (Müll.Arg.)Hale
Flavoparmelia scabrosina Elix & Johnston
Flavoparmelia secalonica Elix & Johnston
Fulgensia bracteata (Hoffm.)Jatta
Fulgensia subbracteata (Nyl.)Poelt
Fuscidea cyathoides (Ach.)V.Wirth & Vezda
Graphis afzelii Ach.
Graphis scripta (Wigg.)Ach.
Haematomma eremaeum R.W.Rogers
Haematomma pruinosum R.W.Rogers
Haematomma puniceum (Ach.)Mass.
Heppia acarosporoides Müll.Arg.
Heterodea beaugleholei R. Filson
Heterodea muelleri (Hampe)Nyl.
Heterodermia dendritica (Pers.)Poelt
Heterodermia japonica (Sato)Swinscow & Krog
Heterodermia obscurata (Nyl.)Trev.
Heterodermia speciosa (Wulfen)Trevisan
Hypocoenomyce australis Timdal
Hypocoenomyce scalaris (Ach.)Choisy
Hypogymnia pulchrilobata (Bitter)Elix

Hypogymnia pulverata (Nyl. ex Crombie)Elix
Hypogymnia subphysodes (Krempelh.)Filson var. austerodioides Elix
Hypogymnia subphysodes (Krempelh.)Filson var. subphysodes
Lecania erysibe (Ach.)Mudd
Lecanora caesiorubella Ach.
Lecanora caesiorubella Ach. ssp. glaucomodes (Nyl.)Imshaug & Brodo
Lecanora campestris (Schaerer)Hue
Lecanora expallens Ach.
Lecanora muralis (Schreb.)Rabenh.
Lecanora pallida (Schreb.)Rabenh.
Lecanora rupicola (L.)Zahlbr.
Lecanora sphaerospora Müll.Arg.
Lecidea contigua (Hoffm.)Fr.
Lecidea glauca Tayl.
Lecidea laeta Stirt.
Lecidea limitata (Scop.)Gray
Lecidea multiflora Tayl.
Lecidea ochroleuca Pers.
Lecidea planata Müll.Arg.
Lecidea templetonii T.Tayl.
Lecidea varians Ach.
Leproloma membranacea (Dickson)Laundon
Leptogium brebissonii Mont.
Leptogium menziesii (Sm.)Ach.
Leptogium phyllocarpum (Pers.)Mont.
Leptotrema
Letrouitia domingensis (Pers.)Hafellner & Bellemere
Lichina minutissima A.Henssen
Lichenothelia scopularia (Nyl.)D. Hawksworth
Menegazzia caesiopruinosa P.James
Menegazzia platytrema (Muell.Arg.)R.Sant.
Microcalicium conversum Tibell
Microthelia micula (Flotow)Körb.
Mycocalicium albonigrum (Nyl.)Tibell
Mycocalicium subtile (Pers.)Szat.
Mycocalicium victoriae (C.Knight ex F.Wilson)Tibell
Mycoporum quercus (Massal.)Müll.Arg.
Neofuscelia imitatrix (Tayl.)Esslinger
Neofuscelia incantata (Esslinger)Esslinger
Neofuscelia loxodella (Esslinger)Esslinger
Neofuscelia pulla (Ach.)Esslinger
Neofuscelia verrucella (Esslinger)Esslinger
Ocellularia
Ochrolechia pallescens (L.)Mass.
Ochrolechia parella (L.)Mass.
Ochrolechia pseudotartarea (Vainio)Verseghy
Ochrolechia subathallina H.Magn.
Ochrolechia subpallescens Verseghy
Pannaria elatior Stirt.
Pannaria pityrea (DC.)Degel.
Pannaria rubiginosa (Thunb. ex Ach.)Delise
Pannoparmelia angustata (Pers.)Zahlbr.
Pannoparmelia wilsonii (Ras.)Galloway
Paraparmelia sammyii Elix & Johnston
Paraparmelia sargentii Elix & Johnston
Parmelina conlabrosa (Hale)Elix & Johnston
Parmelina endoleuca (Tayl.)Hale

Parmelina labrosa (Zahlbr.)Elix & Johnston
Parmelina quercina (Willd.)Hale
Parmentaria microspora Muell.Arg.
Parmotrema cooperi (J.Stein & Zahlbr.)Serusiaux
Parmotrema dilatatum (Vainio)Hale
Parmotrema chinense (Osbeck)Hale & Ahti
Parmotrema praesorediosum (Nyl.)Hale
Parmotrema reticulatum (Tayl.)Choisy
Parmotrema subrugatum (Kremplh.)Hale
Parmotrema subsumptum (Nyl.)Hale
Parmotrema tinctorum (Nyl.)Hale
Peccania
Peltigera dolichorhiza (Nyl.)Nyl.
Peltigera spuria var. erumpens (Ach.)DC. ex Lam. & DC.
Peltula australiensis (Müll.Arg.)R.Filson
Peltula euploca (Ach.)Poelt ex Ozenda & Clauz.
Peltula omphaliza (Nyl.)Wetmore
Peltula placodizans (Zahlbr.)Wetmore
Pertusaria flavicans Lamy
Pertusaria hymenea (Ach.)Schaerer
Pertusaria leioplaca (Ach.)DC.
Pertusaria leioplacella Nyl.
Pertusaria pertusa (L.)Tuck.
Pertusaria pustulata (Ach.)Duby
Phaeographina
Phaeographis
Phaeophyscia endococcinoides (Poelt)Esslinger
Phaeophyscia orbicularis (Necker)Morburg
Phaeotrema
Physcia aipolia (Ehrh. ex Humb.)Fürnr.
Physcia alba (Fée)Müll.Arg.
Physcia albicans (Pers.)Thomson
Physcia caesia (Hoffm.)Furnr.
Physcia stellaris (L.)Nyl.
Physcia tribacia (Ach.)Nyl.
Physcia virella (Ach.)Flagey
Physconia pulverulenta (Hoffm.)Poelt
Placopsis perugosa (Nyl.)Nyl.
Pleurotrema pyrenuloides Müll.Arg.
Polysporina simplex (Davies)Vezda
Porocyphus lichenelloides A.Henssen
Porpidia macrocarpa (DC.)Hertel & Schwab.
Pseudocyphellaria aurata (Sm.)Vainio
Pseudocyphellaria billardierei (Delise)Räsänen
Pseudocyphellaria crocata (L.)Vainio
Pseudocyphellaria neglecta (Müll.Arg.)H.Magn.
Pseudocyphellaria richardii (Mont.)Mass.
Psora decipiens (Hedwig.)Hoffm.
Psoroma sphinctrinum (Mont.)Nyl.
Punctelia subalbicans (Stirt.)Galloway & Elix
Punctelia subrudecta (Nyl.)Krog
Pyxine coccifera (Fée) Nyl.
Pyxine cocoes (Sw.)Nyl.
Pyxine petricola Nyl.
Pyxine subcinerea Stirt.
Ramalea cochleata Müll.Arg.
Ramalina australiensis Nyl.

Ramalina canariensis Steiner
Ramalina celastri (Sprengel)Krog & Swinscow subsp. celastri (Ach.)N.Stevens
Ramalina celastri (Sprengel) Krog & Swinscow subsp. ovalis (J.D.Hook. & Tayl.) N.Stevens
Ramalina fissa (Müll.Arg.)Vainio
Ramalina glaucescens Krempelh.
Ramalina inflata (J.D.Hook. & Tayl.)J.D.Hook. & Tayl. subsp. **australis** N.Stevens
Ramalina subfraxinea Nyl. var. subfraxinea Nyl.
Ramalina subfraxinea Nyl. var. norstictica N.Stevens
Rhizocarpon geographicum (L.)Lam & DC.
Rhizocarpon polycarpon (Hepp.)Th.Fr.
Rhizocarpon tinei (Tornab.)Runemark
Rinodina bischoffii (Hepp)Mass.
Rinodina thiomela (Nyl.)Müll.Arg.
Rinodinella halophila (Müll.Arg.)Mayrhofer
Rocella montagnei Bel.
Sarcogyne clavus (DC.)Kremph.
Sarcogyne privigna (Ach.)Massal.
Sarcogyne regularis Koerber
Siphula coriacea Taylor ex Nyl.
Siplonema paradoxum Born.
Solenopsora vulturiensis Massal.
Stereocaulon corticatulum Nyl.
Synalissa symphorea (Ach.)Nyl.
Teloschistes chrysopthalmus (L.)Th.Fr.
Teloschistes sieberianus (Laurer)Hillman
Tephromela atra (Hudson)Hafellner
Thelotrema lepadinum (Ach.)Ach.
Thysanothecium hookeri Mont. & Berk.
Thysanothecium scutellatum (Fr.)Galloway
Toninia australiensis (Müll.Arg.)Zahlbr.
Toninia caeruleonigricans (Lightf.)Th.Fr.
Toninia cumullata (Sommerf.)Th.Fr.
Trapelia coarctata (Turner)Choisy
Trapelia mooreana (Carrol)P.W.James
Umbilicaria polyphylla (L.)Baumg.
Usnea angulosa (Müll.Arg.)Mot.
Usnea arida Mot.
Usnea ceratina Ach.
Usnea consimilis Stirt.
Usnea inermis Mot.
Usnea pulvinata Fr.
Usnea scabrida Taylor
Usnea torulosa (Müll.Arg.)Zahlbr.
Usnea xanthopoga Nyl.
Verrucaria calciseda DC.
Verrucaria maura Wahlenb. ex Ach.
Verrucaria sphinctrina (Dufour)Ach.
Xanthoparmelia alternata Elix & Johnston
Xanthoparmelia amplexula (Stirton)Elix & Johnston
Xanthoparmelia antleriformis (Elix)Elix & Johnston
Xanthoparmelia arapilensis (Elix & P.Armstr.)R.Filson
Xanthoparmelia australasica D.Galloway
Xanthoparmelia bellatula (Kurok. & Filson) Elix & Johnston
Xanthoparmelia cheelii (Gyelnik)Hale
Xanthoparmelia concomitans Elix & Johnston

Xanthoparmelia congenis (B.Stein)Hale
Xanthoparmelia congesta (Kurok. & Filson)Elix & Johnston
Xanthoparmelia constipata (Kurok. & Filson)Elix & Johnston
Xanthoparmelia cravenii Elix & Johnston
Xanthoparmelia dayiana (Elix & P.Armstr.)Elix & Johnston
Xanthoparmelia dichotoma (Elix & P.Armstr.)Elix & Johnston
Xanthoparmelia digitiformis (Elix & P.Armstr.)R.Filson
Xanthoparmelia dissitifolia Kurok. ex Elix & Johnston
Xanthoparmelia donneri Elix & Johnston
Xanthoparmelia eilifii Elix & Johnston
Xanthoparmelia elixii R.Filson
Xanthoparmelia everardensis (Elix & Armstr.)Elix & Johnston
Xanthoparmelia exillima (Elix)Elix & Johnston
Xanthoparmelia filarszkyana (Gyel.)Hale
Xanthoparmelia filsonii Elix & Johnston
Xanthoparmelia flavescentireagens (Gyel.)D.Galloway
Xanthoparmelia flindersiana (Elix & Armstr.)Elix & Johnston
Xanthoparmelia fumigata (Kurok.)Elix & Johnston
Xanthoparmelia furcata (Müll.Arg.)Hale
Xanthoparmelia gerhardii Elix & Johnston
Xanthoparmelia glareosa (Kurok. & Filson) Elix & Johnston
Xanthoparmelia globulifera (Kurok. & Filson) Hale
Xanthoparmelia gongylodes Elix & Johnston
Xanthoparmelia hypoleia (Nyl.)Hale
Xanthoparmelia incerta (Kurok. & Filson) Elix & Johnston
Xanthoparmelia incrustata (Kurok. & Filson)Elix & Johnston
Xanthoparmelia isidiigera (Müll.Arg.)Elix & Johnston
Xanthoparmelia isidiosa (Müll.Arg.)Elix & Johnston
Xanthoparmelia lineola (Berry)Hale
Xanthoparmelia louisii Elix & Johnston
Xanthoparmelia metaclystoides (Kurok. & Filson)Elix & Johnston
Xanthoparmelia mexicana (Gyel.)Hale
Xanthoparmelia molliuscula (Ach.)Hale
Xanthoparmelia mougeotina (Nyl.)D.Galloway
Xanthoparmelia nana (Kurok.)Elix & Johnston
Xanthoparmelia nashii Elix & Johnston
Xanthoparmelia neorimalis (Elix & Armstr.)Elix & T.Nash
Xanthoparmelia neotinctina (Elix)Elix & Johnston
Xanthoparmelia norpumila Elix & Johnston
Xanthoparmelia notata (Kurok.)Hale
Xanthoparmelia oleosa (Elix & P. Armstr.) Elix & T.Nash
Xanthoparmelia parvoclystoides Elix & Johnston
Xanthoparmelia parvoincerta Elix & Johnston
Xanthoparmelia pertinax (Kurok. & Filson)Elix & Johnston
Xanthoparmelia praegnans (Elix & P.Armstr.)Elix & Johnston
Xanthoparmelia prodomokosii Elix & Johnston
Xanthoparmelia norpraegnans Elix & Johnston
Xanthoparmelia pumila (Kuork. & Filson)Elix & Johnston
Xanthoparmelia pustuliza (Elix)Elix & Johnston
Xanthoparmelia remanens (Elix)Elix & Johnston
Xanthoparmelia reptans (Kurok.)Elix & Johnston
Xanthoparmelia rupestris Elix & Johnston
Xanthoparmelia scabrosa (Taylor)Hale
Xanthoparmelia subcrustacea (Gyel.)Hale
Xanthoparmelia subdistorta (Kurok.)Hale
Xanthoparmelia subnuda (Kurok.)Hale
Xanthoparmelia substrigosa (Hale)Hale

Xanthoparmelia succedans Elix & Johnston
Xanthoparmelia taractica (Krempelh.)Hale
Xanthoparmelia tasmanica (J.D.Hook. & Tayl.)Hale
Xanthoparmelia tegeta Elix & Johnston
Xanthoparmelia terrestris (Kurok. & Filson)Elix & Johnston
Xanthoparmelia versicolor Hale
Xanthoparmelia weberi (Hale)Hale
Xanthoparmelia willisii (Kurok. & Filson) Elix & Johnston
Xanthoparmelia xanthomelaena (Müll.Arg.)Hale
Xanthoparmelia xanthosorediata (Elix) Elix & Johnston
Xanthoria candelaria var.laciniosa (Dufour)Arn.
Xanthoria ligulata (Körber)P.W.James
Xanthoria parietina (L.)Th.Fr.

Specimens Known Only From Type Locality

Acarospora negligens H.Magn.
Western Australia. R. Helms No. 94, on Elder Expedition. Syntype (G and MEL)

Buellia desertorum Müll.Arg.
"saxicola in Western Australia, in Victoria Desert", R.Helms No.51, on Elder Expedition. Holotype (G) Isotype (MEL)

Buellia glomerulans (Müll.Arg.)Zahlbr.
as *Catolechia glomerulans*, "ad terram sabulosam rubidam, prope Wallangering", R. Helms No. 55, on Elder Expedition. Holotype (G)

Caloplaca erythrosticta (Taylor)Zahlbr.
as *Lecanora erythrosticta*, "on bark, Swan River", James Drummond No. 78. Holotype (G) Isotype (BM)

Caloplaca lateritia (Taylor)Zahlbr.
as *Lecidea lateritia*, "on rocks, Swan River", James Drummond. Holotype (FH)

Haematomma pruinosum R.W.Rogers
Mount Manning, Western Australia, A.V.Milweski, 10.iv.1980. Holotype (PERTH)

Lecidea multiflora Taylor
"On bark, Swan River", James Drummond 1843. Holotype (FH) Isotype (BM)

Lecidea ochroleuca Pers.
"Dampier Bay, Peron Peninsula, Shark Bay", C. Gaudichad-Beaupré 1818.
Type not located.

Lichina minutissima A.Henssen
Kumarl to Lake King Road, 14 miles west of Kumarl, R.Filson, 9.x.1966.
Holotype (MEL) Isotype (MB)

Paraparmelia sammyii Elix & Johnston
Yillimining Rock, 20 km east of Narrogin, on road to Harrismith, J.Elix and M.Sargent. Holotype (CBG) Isotype (MEL)

Paraparmelia sargentii Elix & Johnston
Yillimining Rock, 20 km east of Narrogin, on road to Harrismith, J.Elix and M.Sargent. Holotype (CBG) Isotype (MEL)

Porocyphus lichenelloides A.Henssen
Rain Gauge Rock, Porongurups, G.G.Smith.
Holotype (MB) Isotype (MEL and UWA)

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Dr. Jack Elix, Australian National University, Canberra , Dr. Gintaras Kantvilas of the Tasmanian Herbarium, Hobart and Dr. Neville Marchant, Western Australian Herbarium, Perth, critically read the manuscript suggesting improvements.

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MYCOTAXON

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MYXOMYCETES FROM CHINA. I

A checklist of Myxomycetes from China

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The earlier records of myxomycetes in China were reported by Nakazawa (1929), Skvortzow (1931), Emoto (1931,1933,1936), S. C. Teng (1933), and Z. H. Zhou (as C. H. Chow, 1937). In 1963, 142 species and varieties of Chinese myxomycetes were recorded by S. C. Teng in his book FUNGI OF CHINA, while in 1977, 164 species were recorded in TAXONOMIC MATERIALS OF MYXOMYCETES, a book compiled by Jilin Agricultural University and the Institute of Microbiology, Academia Sinica. Since then, more materials have been added (Z. H. Zhou & H. Z. Li, 1978,1983, 1985; Z. H. Zhou et al., 1981; Z. H. Zhou & Y. Li, 1983; Y. Li, 1981, 1983; H. Z. Li, 1988; Z. L. Liu, 1981; Y. F. Zhao, 1983; C. H. Liu, 1980, 1981, 1982, 1983; B. Ing, 1988; and C. L. Champion, 1980). During the last decade, many specimens in some regions of Northeast, Southwest, Southern, and Eastern China have been collected and identified by us. This paper is a compilation of all the known species of myxomycetes from China. Localities from which each species has been collected are indicated by numbers, which are marked with an asterisk when representing a new distribution for that species.

LOCALITIES

1. Beijing 2. Tianjin 3. Hebei 4. Shanxi 5. Nei Mongol 6. Liaoning 7. Jilin 8. Heilongjiang 9. Shanghai 10. Jiangsu 11. Zhejiang 12. Anhui 13. Fujian 14. Jiangxi 15. Shandong 16. Henan 17. Hubei 18. Hunan 19. Guangdong 20. Guangxi 21. Sichuan 22. Guizhou 23. Yunnan 24. Xizang 25. Shaanxi 26. Gansu 27. Qinghai 28. Ningxia 29. Xinjiang 30. Taiwan 31. Hainan 32. Hong Kong 33. Macao.

Species of Myxomycetes

Ceratiomyxales

Ceratiomyxa fruticulosa (Muell.) Macbr., common.

Echinosteliales

Clastoderma debaryanum Blytt., 7, *13, 19, 30.
Echinostelium minutum de Bary, 7, * 17 19, 30, 31, 32.

Liceales

Cribraria argillacea (Pers.) Pers., 7, *17, 30.
Cribraria atrofusca Martin & Lovejoy, 7. *13.
Cribraria aurantiaca Schrad., 3, 7. 13.
Cribraria confusa Nann.-Brem. & Yam. (=C. zhoui Y. Li), 7.
Cribraria dictyospora Martin & Lovejoy, 7.
Cribraria enodis Zhou Z. H. & Y. Li, 25.
Cribraria intricata Schrad., 6, 7. *13, *17, 30.
Cribraria languescens Rex., 7, 10, 13, 30.
Cribraria macrocarpa Schrad., 7, 30.
Cribraria martinii Nann.-Brem., 7.
Cribraria microcarpa (Schrad.) Pers., 7. 11, 12, 13. 17.
Cribraria minutissima Schw., 7, 13, *17, 30, 32.
Cribraria montana Nann.-Brem., 7.
Cribraria oregana H. C. Gilbert, 7.
Cribraria piriformis Schrad., 7, 13, 30.
Cribraria purpurea Schrad., 7.
Cribraria rufa (Roth) Rost., 7.
Cribraria splendens (Schrad.) Pers., 7, 12, *17.
Cribraria tenella Schrad., 1, 3, 7, 11, 13, 30, 31.
Cribraria violacea Rex., 7, 10, 13, *17, 21, 30, 32.
Cribraria vulgaris Schrad., 7, 21.
Dictydiaethelium plumbeum (Schum.) Rost., 7, 8, 12, *13, *17, 18, 23, 30, 31.
Dictydium cancellatum (Batsch.) Macbr., common.
Dictydium mirabile (Rost.) Mylan., 12, 24.
Licea biforis Morgan, 8, *13, *17.
Licea denudescens Keller & Brooks, 19.
Licea erectoides Nann,-Brem. & Yam., 32.
Licea kleistobolus Martin, 32.
Licea minima Fries, 7.
Licea operculata (Wingate) Martin, *13, *17. 30. 32.
Licea pedicellata (H. C. Gilbert) H. C. Gilbert, 32.
Licea scyphoides Brooks & Keller, 32.
Lindbladia tubulina Fries, 3, 7, *8, 11, 12.
Lycogala conicum Pers., 7, *13, 30.
Lycogala epidendrum (L.) Fries, common.
Lycogala exiguum Morgan, common.

432	39	*for*	Platyearpon	*read*	platycarpum
	45	*for*	crutaceum	*read*	crustaceum

Lycogala flavofuscum (Ehrenb.) Rost., *1, 3, 4,10, *29, 30.
Enteridium lycoperdon (Bull.) Farr, 3, *4, 7, *8, *13, 23, 26, 27, 29, 30.
Enteridium splendens (Morgan) Macbr., 3, *4, 7, *8, 20. 25, 26.
Tubifera casparyi (Rost.) Macbr., 7.
Tubifera ferruginosa (Batsch) J. F. Gmelin, *4, 6, 7, 11, 12, *13, *17, 21, 23, *25, 29, 30.
Tubifera microsperma (Berk. & Curt.) Martin, 7, *13, 30.

Trichiales

Arcyria annulifera Torrend, 30.
Arcyria carnea (G. Lister) G. Lister, 8, *13, 30.
Arcyria cinerea (Bull.) Pers., 3, 6, 7, 8, 10, 11, 12, 13, *14, *17, 18, 23, *24, *26, 30, 31, 32.
Arcyria denudata (L.) Wettst., common.
Arcyria ferruginea Santer., 7, *8, 26.
Arcyria glauca A. Lister, 3, 10, *13.
Arcyria globosa Schw., 12, *21.
Arcyria incarnata (Pers.) Pers., 3, 7, *13, *17, 19, 23, 30, 31.
Arcyria insignis Kalchbr. & Cooke, 6, 7, *13. 30.
Arcyria leiocarpa (Cooke) Martin & Alexop., 12.
Arcyria magna Rex., *1, 3, 7.
Arcyria major (G. Lister) Ing, 19, 20, 31, 33.
Arcyria nigella Emoto, 7.
Arcyria nutans (Bull.) Grev., *1, 10, *13, *17, *19, 30. *31.
Arcyria occidentalis (Macbr.) G. Lister, 3, *8, *17.
Arcyria oerstedtii Rost., *8, *13, 29.
Arcyria pomiformis (Leers) Rost., 6, 7, 10, 12, *13, 30.
Arcyria stipata (Schw.) A. Lister, *1, 3, 7, *17.
Arcyria versicolor Phill., 23.
Arcyria virescens G. Lister, 1, *13, 23.
Calomyxa metallica (Berk.) Nieuwl., *6, 30.
Hemitrichia calyculata (Speg.) Farr, 3, *6, 7, *8, *13, *15, *17, *19, *23, *25, 30.
Hemitrichia chrysospora (A. Lister) A. Lister, *6, 11, 12.
Hemitrichia clavata (Pers.) Rost., common.
Hemitrichia imperialis G. Lister, *1, 3, *6, 7.
Hemitrichia karstenii (Rost.) A. Lister, 12.
Hemitrichia serpula (Scop.) Rost., common.
Metatrichia vesparium (Batsch) Nann.-Brem., common.
Perichaena chrysosperma (Currey) A. Lister, 4, 7, 13, 30. 32.
Perichaena corticalis (Batsch) Rost., 7, 30.
Perichaena depressa Libert, 6, 7. 8, *13, *23, 30.
Perichaena minor (G. Lister) Hagelst.(=Hemitrichia minor Ing), 7, 32.

Perichaena vermicularis (Schw.) Rost., 7, 13, *23, 30.
Trichia botrytis (J. F. Gmel.) Pers., *5, *6, 7, 12, *13, *17, 21, 30.
Trichia contorta (Ditmar) Rost., 7, 8, *25, 26, 27, 29, 30.
Trichia decipiens (Pers.) Macbr., 3, *5, *6, 7, *8, *13, *17, 20. 21, *23.
Trichia favoginea (Batsch.) Pers., common.
Trichia floriformis (Schw.) G. Lister, *5, 7, 30.
Trichia lutescens (A. Lister) A. Lister, 3, 7.
Trichia scabra Rost., *5, 6, 7, *13, *17, 18. 23, 25, 27, 30.
Trichia subfusca Rex., 7.
Trichia varia (Pers.) Pers., 3, *5, *6, 7, 8, *13, *18, *25.
Trichia verrucosa Berk., 30, 31.

Physarales
Badhamia affinis Rost., 1, 3, 4, 6, 7, 13.
Badhamia capsulifera (Bull.) Berk., *17.
Badhamia macrocarpa (Ces.) Rost., 4, 5, 7, 8, 13, 17, 26.
Badhamia nitens Berk., 30.
Badhamia obovata (Peck.) S. T. Smith, *8.
Badhamia utricularis (Bull.) Berk., 4, 7, 11, 27.
Badhamiopsis ainoae (Yamashiro) Brooks & Keller, 7.
Craterium aureum (Schum.) Rost., 3, 7.
Craterium concinnum Rex., 7, 12.
Craterium leucocephalum (Pers.) Ditm., 1. 3, 6, 7, 12.
Craterium minutum (Leers) Fries, *1, 3, 7.
Craterium rubronodum G. Lister, 7.
Cienkowskia reticulata (Alb. & Schw.) Rost., 7, 23, 30.
Diderma asteroides (A. & G. Lister) G. Lister, 7, 25.
Diderma chondrioderma (de Bary & Rost.) G. Lister, 13, 30, 32.
Diderma cor-rubrum Macbr., 7.
Diderma effusum (Schw.) Morgan., 1, 3, 7, 11, 13, 32.
Diderma floriforme (Bull.) Pers., 26.
Diderma globosum Pers., 3, 7, 8.
Diderma hemisphaericum (Bull.) Hornem., 3, 7, 10, *13, 20.
Diderma lyallii (Massee) Macbr., 7.
Diderma Platyearpon Nann.-Brem., 30.
Diderma radiatum (L.) Morgan., 29.
Diderma spumarioides (Fries) Fries, 1, 3, 8, 10, 18, 26, 27.
Diderma testaceum (Schrad.) Pers., 4.
Didymium anellus Morgan, 7.
Didymium clavus (Alb. & Schw.) Rab., 10, 13.
Didymium crutaceum Fries, *8.
Didymium difforme (Pers.) S. F. Gray, 10, 32.

Didymium eximium Peck em. Nann.-Brem., 30, 31.
Didymium intermedium Schroet., 12.
Didymium iridis (Ditmar.) Fries, 7, 8, 12, 13.
Didymium leonium Berk. & Br., 8, 21.
Didymium melanospermum (Pers.) Macbr., 3, 7, 25.
Didymium minus (A. Lister) Morgan, 7, 10, 11, 12, *13, 20.
Didymium nigripes (Link) Fries, 1, 3, 6, 7, *8, 10, 12, 13, 18, 23, 25, 31.
Didymium ovoideum Nann.-Brem., 30.
Didymium proximum Berk. & Curt, 31.
(This segregate from *D. iridis* not previously separated in Asia.)
Didymium squamulosum (Alb. & Schw) Fries, common.
Didymium serpula Fries, 30.
Didymium vaccinum (Dur. & Mont.) Buchet, 7.
Didymium verrucosporum Welden, 30.
Erionema aureum Penzig., 12, 13.
Fuligo cinerea (Schw.) Morgan, *13, 30.
Fuligo intermedia Macbr., 30.
Fuligo licenti Buchet, 4.
Fuligo muscorum Alb. & Schw., 8.
Fuligo rufa Pers., 8.
Fuligo septica (L.) Wiggers, common.
Mucilago crustacea Wiggers, *1, 3, 4, 7, 26.
Paradiacheopsis cribrata Nann.-Brem., 19.
Physarella oblonga (Berk. & Curt.) Morgan, *1, 7, *13, *19.
Physarum alpinum (A. & G. Listr) G. Lister, 7.
Physarum bethelii Macbr., 19.
Physarum bivalve Pers., 3, 4, 7, 10, 11, 12, 13.
Physarum bogoriense Racib., 13, 27.
Physarum brunneolum (Phill.) Massee, 7.
Physarum cinereum (Batsch) Pers., *1, 3, 6, 7, *8, *13.
Physarum citrinum Schum., 13.
Physarum compressum Alb. & Schw., 3, 4, 6, 7, 8, 10, 13, 31.
Physarum contextum (Pers.) Pers., 7.
Physarum crateriforme Petch, 13, 30.
Physarum decipiens Curtis, 32.
Physarum diderma Rost., 1, 7, 11.
Physarum didermoides (Pers.) Rost., 4, 7, *8, *12, 23, 31.
Physarum flavicomum Berk., 1, 8, 10, 12, 13, 31.
Physarum galbeum Wingate, 7.
Physarum globuliferum (Bull.) Pers., 1, 3, 13, 31.
Physarum gyrosum Rost., 3, 4, 7, 10, 29.
Physarum javanicum Racib., 13.
Physarum lateritium (Berk. & Rav.) Morgan, 7.
Physarum leucopus Link., 3, 7, 10, 11, 12, 30.
Physarum leucophaeum Fries, 8, 13.

Physarum listeri Macbr., 3, 7.
Physarum luteolum Peck, 7, 13.
Physarum megalosporum Macbr., 10, 13.
Physarum melleum (Bark. & Br.) Massee, 10, 12, 13, 20, 21, 23.
Physarum nicaragense Macbr., 6, 7, 13, 30.
Physarum notabile Macbr., 7, 30.
Physarum nucleatum Rex, 13.
Physarum nutans Pers., 1, 3, 6, 7, 10, 13, 19, 21.
Physarum oblatum Macbr., 12, 13, 21, 23, 31, 32.
Physarum ovisporum G. Lister, 30.
Physarum penetrale Rex, *13.
Physarum pezizoideum (Jungh.) Pav. & Lag., 7, 13, 14, 20, 22, 23, 31.
Physarum polycephalum Schw., 1, 3, 8, 10, 31.
Physarum psittacinum Ditmar., 7, 13.
Physarum pusillum (Berk. & Curt.) G. Lister, 3, 4, 7, 8, 11, 13, 20, 21, 23.
Physarum puniceum Emoto, *1, 3, 6.
Physarum rigidum (G. Lister) G. Lister, 7, 13, 20. 31.
Physarum roseum Berk & Br., 13, 19.
Physarum sessile Brandza, 1, 3, 30, 32.
Physarum serpula Morgan, 8, 13, 30.
Physarum stellatum (Massee) Martin, 30.
Physarum straminipes A. Lister, 30.
Physarum sulphureum Alb. & Schw., 1, 3.
Physarum tenerum Rex, 7, 10, 13, 19, 31.
Physarum vernum Somm., 3, 4, 5, 7, 13.
Physarum virescens Ditmar., 13.
Physarum viride (Bull.) Pers., 1, 3, 7, 8, 11, 12, 13, 18, 20, 21, 23, 31.

Stemonitales

Amaurochaete atra (Alb. & Schw.) Rost., *13, 29.
Comatricha cylindrica (Bilgram.) Macbr., 11.
Comatricha dictyospora Celak., 12.
Comatricha elegans (Racib.) G. Lister, 12, 13.
Comatricha irregularis Rex, *1, 3, 25.
Comatricha laxa Rost., 7, 10, 12.
comatricha longa Peck, *1, 3, 10, *13, 23, 31.
Comatricha lurida A. Lister, 7.
Comatricha nigra (Pers.) Schroet., 6, 7, 10, 13, 20, 32.
Comatricha pulchella (C. Bab.) Rost., 10, *13.
Comatricha subcaespitosa Peck, 13.
Comatricha tenerrima (M. A. Curt.) G. Lister, 32.
Comatricha typhoides (Bull.) Rost., 3. 7. *8, 10. 13, 23, 25, 31.
Diachea bulbillosa (Berk. & Br.) A. Lister, 3, 6, 12.

Diachea leucopodia (Bull.) Rost., *1, 3, 4, 10, *13, 20, 21, 26.
Diachea splendens Peck, 6, 7.
Diachea subsessilis Peck, 20.
Diachea synspora H. Z. Li, 17.
Enerthenema papillatum (Pers.) Rost., 7. 32.
Lamproderma arcyrionema Rost., 7, *13, 19, 30, 31.
Lamproderma columbinum (Pers.) Rost., 7.
Lamproderma scintillans (Berk. & Br.) Morgan, 7, 10, 11, 14, 20.
Macbrideola cornea (G. Lister & Cran) Alexop., 30.
Stemonitis axifera (Bull.) Macbr., 9, 12, 13, 19, 24.
Stemonitis flavogenita Jahn, 12, 13, 30.
Stemonitis fusca Rost., common.
Stemonitis herbatica Peck, 3, 7, 8, 10, 12, 13, 23, 31.
Stemonitis hyperopta Meylan, 13.
Stemonitis microsperma B. Ing, 30.
Stemonitis nigrescens Rex, 7, 9, 12, 13.
Stemonitis pallida Wingate, 6, 7, 13, 23, 31.
Stemonitis smithii Macbr., 7., 8, 12, 13.
Stemonitis splendens Rost., Common
Stemonitis trechispora (Berk.) Macbr., 30.
Stemonitis uvifera Macbr., 30.
Stemonitis virginiensis Rex, 7, 13, 30.

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MYCOTAXON

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NEW SPECIES IN THE LICHEN FAMILY THELOTREMATACEAE FROM ASIA (ASCOMYCOTINA)

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Abstract: The following 16 species in the lichen family Thelotremataceae from southeast Asia are described as new: *Myriotrema craterellum* Nagarkar & Hale, *M. extendens* Nagarkar & Hale, *M. lunense* Nagarkar & Hale, *M. permaculatum* Nagarkar & Hale, *M. sembilanense* Nagarkar & Hale, *M. viride* Nagarkar & Hale, *Ocellularia bakoensis* Nagarkar & Hale, *O. deformis* Nagarkar & Hale, *O. flavomedullosa* Nagarkar & Hale, *O. gentingensis* Nagarkar & Hale, *O. inexpectata* Nagarkar & Hale, *O. kinabalensis* Nagarkar & Hale, *O. pruinata* Nagarkar & Hale,*O. tuberculata* Nagarkar & Hale, *Thelotrema fissuratum* Nagarkar & Hale, *T. verruculosum* Nagarkar & Hale. The following new combinations are made: *M. microphthalmum* (Müll. Arg.) Nagarkar & Hale, *Ocellularia auberianoides* (Nyl.) Nagarkar & Hale, Nagarkar & Hale, and *O. eurychades* (Krempelh.) Nagarkar & Hale.

Introduction

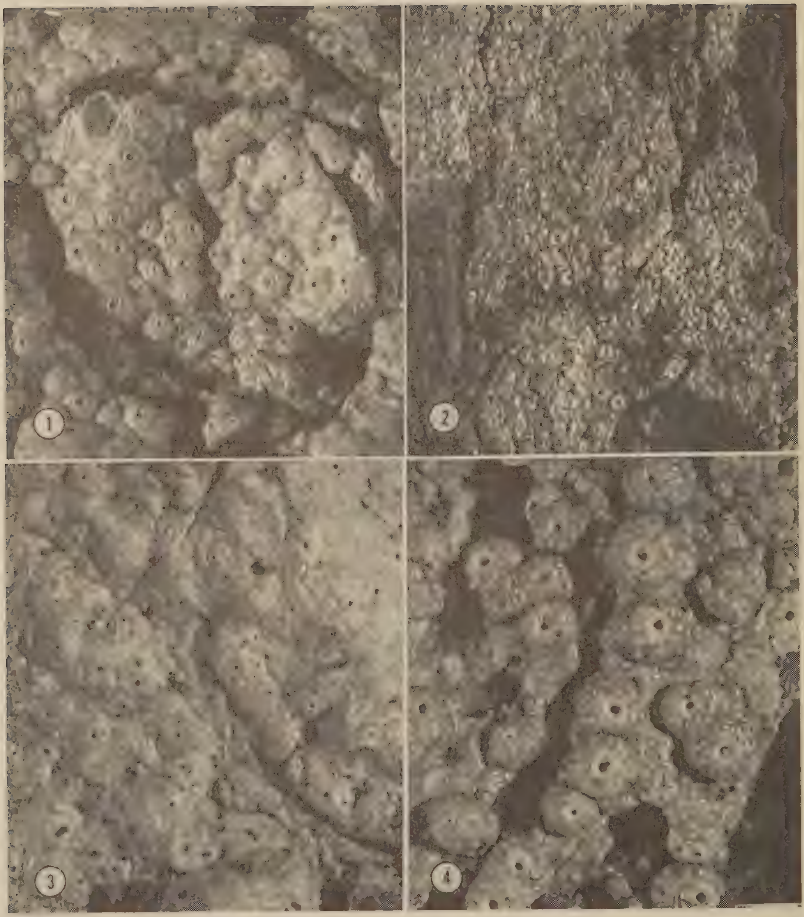
The following new species are based for the most part on specimens collected by the junior author in Malaysia, Sri Lanka, and the Philippines. Most of the localities were virgin dipterocarp logging areas, where the Thelotremataceae are exceptionally well developed. This habitat is rapidly disappearing throughout southeast Asia as large-scale commercial timbering for lauan used in vaneer manufacture continues unabated since the end of World War II. These forests are replaced by an impoverished secondary scrub, replanted with fast-growing *Albizzia falcata* or tung oil, or turned into pasture. Only rarely are conservation measures taken to preserve the continuity of the dipterocarp forest community, and consequently the Thelotremataceae flora is being lost forever.

The generic delimitation of the family is still unsettled. The old spore-based genera (*Ocellularia, Phaeotrema, Thelotrema,* and *Leptotrema*) served well for nearly 100 years but are now considered to be artificial. Hale (1981) introduced three exicpular-based genera (*Myriotrema, Ocellularia,* and *Thelotrema*) in a treatment of the large Sri Lankan flora. Spore characters were relegated a secondary role in the taxonomy. While extremely few lichenologists have tested the validity of this approach, our experience has convinced us that both *Myriotrema* and *Ocellularia* so delimited overlap in many areas and appear to be unacceptably heterogeneous. By comparison, *Thelotrema* is a relatively homogeneous group.

What is needed is a modern, comprehensive study of ascocarp ontogeny in the family, but this will not be made soon. In the meantime we will continue using excipular-based genera with the realization that this generic delimitation could well change significantly in the future.

Myriotrema craterellum Nagarkar & Hale, sp. nov.

Thallus (Fig. 1) corticola, laevis, apothecia numerosa, emergentia, basin constricta, 0.4 – 0.6



Figures 1-4. Holotypes of *Myriotrema* species: 1, *M. craterellum; 2, M. extendens*; 3, *M. lunense*; 4, *M. permaculatum*. Scale for all species equals 1 mm (See Fig. 4).

mm diametro, excipulo connato; pseudocolumella nigricans; ostiolum rotundatum; sporae fuscae, 8:nae, 4–6 × 12–16 μm, transversim 6-loculatae.

Holotype: Sabah, Near Mt. Silam, Kennedy Bay Lumber concession, logging area in virgin dipterocarp forest, elev. ca 150 m, *M. E. Hale* 34,610, 16 March 1965 (US).

Thallus corticolous, white, smooth, cracked with age, to 10 cm broad; cortex indistinct; apothecia numerous, closely aggregated, semi-emergent to emergent, becoming basally constricted, 0.4-0.6 mm in diameter; exciple fused, reddish brown, dark brownish black at the tips, with incorporated bark elements; pseudocolumella thin, 45-60 μm in diameter, fromed by clumping of paraphyses and dead spore cells, brown to dark brownish black; ostiole rotund with a slightly raised, thin, white ring, the pore 0.09–0.14 mm in diameter; hymenium 100–120 μm high; spores brown, 8/ascus, transversely 6-loculate, 4–6 × 12–16 μm.

Chemistry: Psoromic acid present.

Observations: *Ocellularia caledoniensis* (Hale) Hale with similar chemistry, spores and a weak columella, has larger apothecia (up to 1.4 mm in diameter) and a depressed pore without any ring.

Myriotrema extendens Nagarkar & Hale, sp. nov.

Thallus (Fig. 2) corticola, hypophloeodes, ca 8 cm latus; apothecia emergentia, 0.8–1.3 mm diametro, margine eroso, medulla lutea; columella nulla; ostiolum irregulare, o.15–0.3 mm latum; hymenium 120–150 μm; sporae 4– 8:nae, incolores, muriformes, 10–12 × 30–38 μm.

Holotype: Sri Lanka, Western Province, Kalutara District, near Hedigalla, Morapitiya logging area; elev. ca. 167 m; 11 Feb. 1976; *M. E. Hale* 47,192 (US).

Thallus greenish grey, minutely verruculose, continuous; cortex 15–18 μm; algal layer 20–24 μm, continuous; medulla up to 60 μm, with small to medium crystals; apothecia numerous, semi-emergent, 0.25–0.35 mm in diameter; exciple fused, sometimes splitting to seperate, yellowish to reddish brown; ostiole circular, with pore-area concolorous to tannish, rim white when exposed, pore 0.06–0.09 mm in diameter; hymenium 65–80 μm high; spores hyaline, transversely 4-loculate, 3–4 × 9–10 μm, I + blue, 8/ascus.

Chemistry: Psoromic acid present.

Observations: This species is close to *M. myriotremoides* (Nyl.) Hale in excipular structure, spore characters, and chemistry, but *M. myriotremoides* lacks a cortex, being typically hyphloeodal. *Myriotrema glaucophaenum* (Krempelh.) Hale has a distinctly corticate thallus, but lacks the typical brown excipular tissue.

Myriotrema lunense Nagarkar & Hale, sp. nov.

Thallus (Fig. 3) corticola, epiphloeodes, 8–10 cm latus; apothecia immersa, 0.4– 0.75 mm diametro, excipulo connato raro fissurato; pseudocolumella 40 μm diametro; ostiolum rotundatum, 0.06–0.1 mm diametro; hymenium 100 μm; sporae fuscae, 8:nae, 8–9 × 12–21 μm, 1–2 × 2–4-loculatae.

Holotype: Philippines, Mountain Province, Luzon, PECORP logging area ca 30 km S of Luna; virgin dipterocarp forest; elev ca 300 m; July 1964; *M. E. Hale* 25878 (US).

Thallus on bark, white mineral grey, smooth, continuous, 8–10 cm broad; cortex indistinct; algal layer 30 μm, continuous; medulla hypophloeodal, with medium crystals; apothecia immersed in bark or slightly raised, 0.4–0.75 mm; exciple fused, cracking to separate in a few apothecia, reddish brown, apically darkening, noncarbonized; a pseudocollumella (40 μm thick) sometimes developing by aggregation of the hymenial elements; pore flush to depressed, concolorous or becoming tannish, rarely with a slightly raised tannish ring 0.06–01 mm in diameter; hymenium 100 μm; spores brown, 12–21 × 8–9 μm, 1–2 × 2–4-loculate, 8/ascus.

Chemistry: No substances present.

Obervations: This species is close to *"Leptotrema" zollingeri* Mont. & v.d.Bosch (generic status not yet determined) from Java in morphology, but *L. zollingeri* contains "Praestans" unknowns and has a verruculose thallus.

Myriotrema permaculatum Nagarkar & Hale, sp. nov.

Thallus (Fig. 4) corticola, epiphloeodes, 3–4 cm latus; apothecia emergentia, 0.8–1.2 mm diametro; ostiolum depressum, albocinctum, 0.07–0.14 mm diametro; columella nulla; hymenium 300 μm; sporae 8:nae, obscurae, 12–15 × 15–27 μm, 1–2 × 3–4-loculatae.

Holotype: Philippines, Basilan Province, Basilan Lumber Co. logging area, about 25 km N of Upper Canas, virgin dipterocarp forest. Elev. ca 300 m. June 1964, *M. E. Hale* 24937 (US).

Thallus on bark, pale tannish grey, verruculose, continuous, 3–4 cm broad; cortex thin, 5–6 μm; algal layer 30 μm, interrupted by crystals; medulla 90–100 μm, with medium-sized crystals; apothecia many, closely disposed, emergent, ascidioid, rounded, 0.8–1.2 mm; exciple fused, reddish brown, with a few bark cells embedded; pore depressed, white rimmed, 0.07–0.14 mm; margin thick, 350–380 μm, largely crystal studded, externally white notched, the notches resembling pseudocyphellae; hymenium 300 μm; spores brown, broadly oval, 12–15 × 15–27 μm, 1–2 × 3–4-loculate, 8/ascus.

Chemistry: Protocetraric acid present.

Observations: *M. bahianum* (Ach.) Hale is close, but has wider pore (up to 0.3 mm), columnar aggregates in the hymenium and lacks the distinct white notches on the margin, charateristic of *M. permaculatum*.

Myriotrema sembilanense Nagarkar & Hale, sp. nov.

Thallus (Fig. 5) corticola, epiphloeodes, 6–8 cm latus; apothecia vix elevata, 0.2–0.3 mm diametro, excipulo connato; columella nulla; ostioum rotundatum, 0.05–0.06 mm diametro; hymenium 75 um; sporae incolores, 8:nae, 2–3 × 6–9 μm, transversim 4–6-loculate.

Holotype: Malaya, State of Negri Sembilan, Kuala Pilah logging area, ca. 8 km N of Seremban, Kuala Pilah road, ca. 10 km W of Kuala Pilah; felled trees in dipterocarp forest; elev. ca. 150 m; 17 Aug. 1983; M.E. Hale 63,050 (US).

Thallus greenish grey, smooth, shiny, minutely verruculose; cortex 12–15 μm, distinct; algal layer 17 μm, continuous; medulla 90–110 μm, with medium-sized crystals; apothecia numerous, slightly elevated, immersed in medulla, 0.2–0.3 mm in diameter; columella lacking; pale brown; pore flush, 0.05–0.06 mm in diameter, bounded by a whitish circular zone; hymenium 75 μm; spores hyaline, transversely 4–6-loculate, 2–3 × 6–9 μm, I + blue, 8/ascus.

Chemistry: Protocetraric acid present.

Additional specimen: Same locality as the type, *M. E. Hale* 63,040 (US).

Observations: This species has close resemblance with *M. immersum* (Eschw.) Hale which, however, has larger spores, 8–10 × 24–26 μm, and a columnar cortex.

Myriotrema viride Nagarkar & Hale, sp. nov.

Thallus (Fig. 6) corticola, epiphloeodes, 5–6 cm latus; apothecia vix elevata in medulla immersa, 0.2–0.3 mm diametro, exciplo connato; ostiolum rotundatum, 0.06–0.07mm diametro; hymenium 120 μm; sporae incolores, 8:nae, muriformes, 5–6 × 15–20 μm, 1–2 × 5–7-loculatae.

Holotype: Malaya, State of Selangor, Genting Hilands, old troop bivouac area below the hotels along main road, remnant mid-elevation rain forest; elev. ca. 1800 m; 16 Aug 1983; *M. E. Hale* 63,111 (US).

Thallus greenish grey, smooth, shiny, continuous; cortex distinct, 21–24 μm; algal layer continuous, 18 μm; medulla 70–80 μm, with medium-sized crystals; apothecia numerous, slightly elevated, immersed in the medulla, 0.2–0.3 mm in diameter; exciple fused, faint reddish brown; pore small, round to irregular, 0.6–0.7 mm in diameter; hymenium 120 μm high; spores hyaline, muriform, 1–2 × 5–7-loculate, 5–6 × 15–20 μm, I + blue, 8/ascus.

Chemistry: Protocetraric acid present.

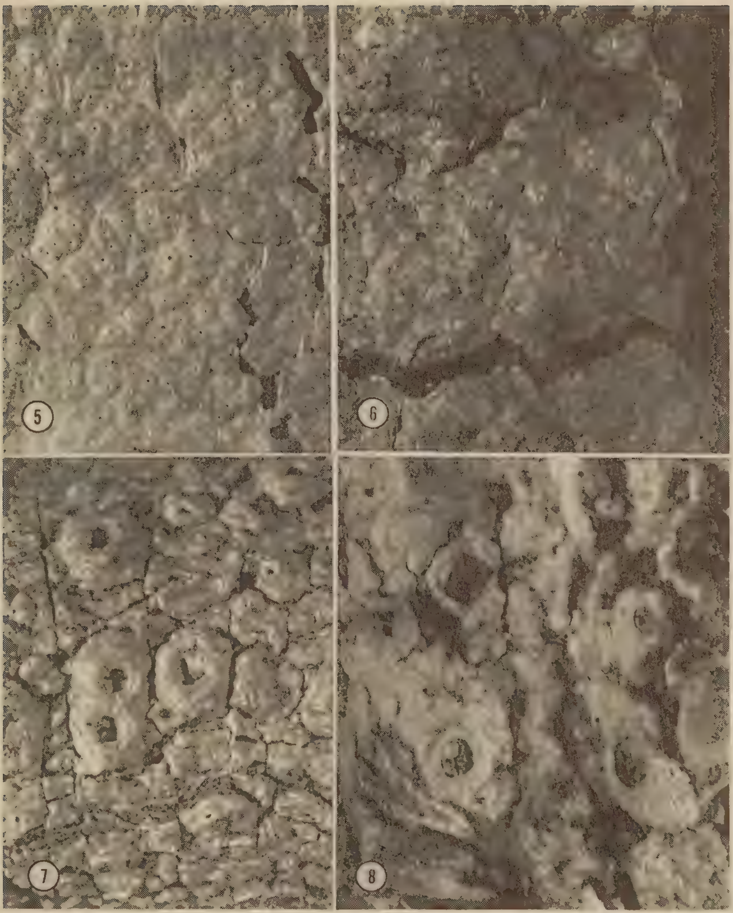
Observations: This species resembles *Myriotrema sembilanense* from Malaya, described above, in all characters except for the dark color, more elevated apothecia, and vertical spore septation. *Myriotrema microphthalmum* (Müll. Arg.) Nagarkar & Hale (comb. nov. Basionym: *Thelotrema microphthalmum* Müll. Arg., Bull. Herb. Boissier 3:314. 1895) from Australia is close but has a thin central columella (type in G!), 48–56 μm.

Ocellularia bakoensis Nagarkar & Hale, sp. nov.

Thallus (Fig. 7) corticola, epiphloeodes, ca 8 cm latus; apothecia emergentia, basin constricta, aetate 1–1.4 mm diametro; columella 400–440 μm diametro, centro fissurina; ostiolum 0.3–0.6 mm diametro; hymenium ad 140 μm; sporae incolores, 8:nae, 10–12 × 35–45 μm, transversim 10–12-loculatae.

Holotype: Sarawak, Bako National Park; Oak-dipterocarp forest; 10 Mar. 1965; *M. E. Hale* 29,834 (US).

Thallus pale greenish grey, smooth to minutely verruculose, regularly fissured, forming more or less rectangular blocks; cortex 30 μm, projecting up to 48 μm; algal layer 30 μm, partly interrupted by medium to large-sized crystals; medulla mostly hypophloeodal; apothecia solitary or rarely 2-



Figures 5-8. Holotypes of *Myriotrema* and *Ocellularia* species: 5, *M. sembilanense*; 6, *M. viride*; 7, *O. bakoensis*; 8, *O. deformis*. See Fig. 4 for scale.

fused, emergent, constricted at the base, rounded, (0.7) 1 – 1.4 mm in diameter; pore circular, 0.3 – 0.6 mm in diameter, concolorous or becoming dark brownish-black rimmed; exciple reddish brown, up to 320 μm thick, carbonized to the base at the inner edge; columella initially simple, wide, 400 – 440 μm in diameter, 140 μm high, becoming fissured in the center, with a heavily pruinose, divided tip visible through the pore, carbonized to the base; hymenium 140 μm high, confined to a narrow peripheral zone 90 μm wide; spores hyaline, transversely 10 – 12-loculate, 10 – 12 × 35 – 45 μm, I + blue, 8/ascus.

Chemistry: Psoromic acid present.

Additional specimens: Same locality as the type, *M. E. Hale* 29,810, 29,819 (US).

Observations: This species resembles *O. eurychades* (Krempelh.) Nagarkar & Hale (comb. nov. Basionym: *Thelotrema eurychades* Krempelh., Nuov. Giorn. Bot. Ital. 7:17. 1875), also from Sarawak, which, however, lacks psoromic acid, and has much thinner exciple, 40 – 50 μm thick. Specimen no. 29,810 has a more distinctly verrucose thallus.

Ocellularia deformis Nagarkar & Hale, sp. nov.

Thallus (Fig. 8) corticola, hypophloeodes, 4 – 6 cm latus; apothecia semi-emergentia, excipulo connato, interiore fuligineo; columella fuliginea, 400 – 720 μm diametro; ostiolum rotundatum vel elongatum, 0.3 – 0.45 mm diametro; hymenium 160 μm; sporae fuscae, 8:nae, 10 – 12 × 18 – 22 μm, transversim 4-loculatae.

Holotype: Sabah, Kinabalu National Park, on ridge between E. and W. Mesilau Rivers; elev. ca. 1800 m; Aug. 1964; *M. E. Hale* 28,377 (US).

Thallus whitish, smooth, minutely fissured with age; cortex lacking; algal layer 20 – 25 μm, continuous; medulla hypophloeodal with small crystals; apothecia semi-emergent, 0.8 – 1.4 mm in diameter; exciple fused, reddish brown, with yellowish brown bark layers present to the outer part, inner part thickly carbonized to the base; columella initially simple, wide, 400 – 720 μm in diameter, 200 μm high, carbonized to the base, fissuring and becoming partially actinoid, with the tips heavily white pruinose; ostiole initially circular, becoming elongate to boat-shaped or angular, with concolorous pore area and black rim, pore gaping, 0.3 – 0.45 mm in diameter; hymenium low, confined to the periphery, 160 μm high, 240 μm thick; spores brown, withered, transversely 4-loculate, 10 – 12 × 18 – 22 μm, 8/ascus.

Chemistry: No substances present.

Observations: In later stages, the apothecia are deformed to some extent, the ostiole becomes elongate to angular, the margin becomes erect, and the columella fissures to become partially actinoid. The species is related to *O. meiosperma* (Nyl.) Hale which has smaller, more immersed apothecia. A similar type of columella is observed in *O. bakoensis*, a new species from Sarawak described above.

Ocellularia flavomedullosa Nagarkar & Hale, sp. nov.

Thallus (Fig. 9) corticola, epiphloeodes, 3 – 5 cm latus; apothecia semi-emergentia, 0.25 – 0.35 mm diametro, excipulo connato; columella nulla; ostiolum 0.06 – 0.09 mm diametro; hymenium 65 – 80 μm; sporae incolores, 8:nae, 3 – 4 × 9 – 10 μm, transversim 4-loculatae.

Holotype: Philippines, Agusan Province, Mindanao, about 30 km SE of Butuan City, Nasipit Lumber Co., Florida logging area; virgin dipterocarp forest; elev. ca 200 m, Aug. 1964; *M. E. Hale* 25,240 (US).

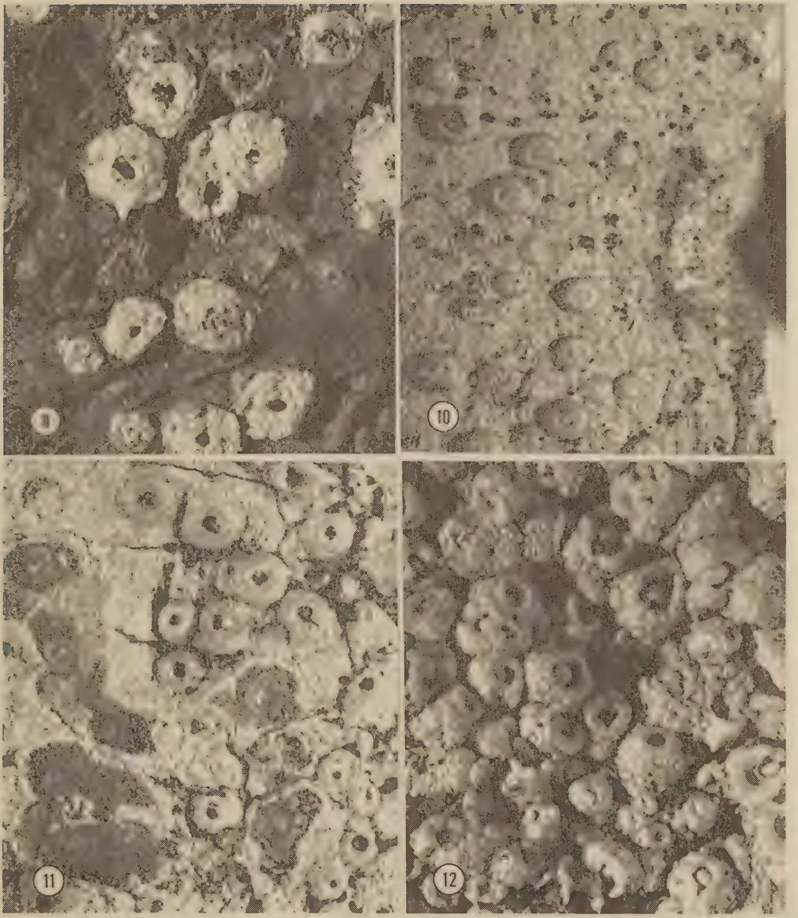
Thallus olivaceous greenish to tannish grey, smooth, continuous; cortex indistinct; algal layer ca. 15 μm, continuous; medulla completely hypophloeodal, with a few medium-sized crystals; apothecia numerous, emergent, basally constricted, 0.8 – 1.3 mm in diameter, solitary or 2 fused, with the top flaking off, exposing a marginal yellow medulla; exciple fused, black to the base, with bark cells; margin thick, 400 – 450 μm thick, filled with yellow powdery substance in medulla; ostiole left as a hole 0.15 – 0.3 mm across, circular to elongate; hymenium 120 – 150 μm high; spores hyaline, muriform, 10 – 12 × 30 – 38 μm, I + blue, 4 – 8/ascus.

Chemistry: Two unknown PD + substances present.

Observations: The apothecia with the top flaking off and exposed light yellow medulla of the margin appear as rounded yellow eruptions over the thallus. No comparable species are known in the genus.

Ocellularia gentingensis Nagarkar & Hale, sp. nov.

Thallus (Fig. 10) corticola, pro parte hypophloeodes, 2 – 8 cm latus; apothecia emergentia, 0.5 – 0.9



Figures 9-12. Holotypes of *Ocellularia* species: 9, *O. flavomedullosa*; 10, *O. gentingensis*; 11, *O. inexpectata*; 12, *O. kinabalensis*. See Fig. 4 for scale.

mm diametro, excipulo connato, fuliginio in parte superiore; columella nulla; ostiolum minutum, 0.05 – 0.08 mm diametro; hymenium 240 μm; sporae incolores, 4 – 8:nae, 9 – 12 × 54 – 96 μm, transversim 13 – 26-loculatae.

Holotype: Malaya, Trail above (N of) Casino, Genting Highlands, just N of Kuala Lumpur; elev. ca. 2000 m; 16 Aug. 1983; *M. E. Hale* 59,894 (US).

Thallus ashy grey, smooth, continuous; cortex indistinct; algal layer 25 – 30 μm, continuous; medulla mostly hypophloeodal, with a few crystals; apothecia emergent, ascidioid, rounded, 0.5 – 0.9 mm in diameter; exciple fused, reddish brown, carbonized in the upper part; pore minute, 0.05 – 0.08 mm in diameter, the pore area concolorous, the rim white when exposed, sometimes slightly raised but a distinct annulate ring not developed; margin thick, 120 μm; hymenium 240 μm; spores hyaline, transversely 13 – 26-loculate, 9 – 12 × 54 – 96 μm, at the average 60 μm long, I+ blue, 4 – 8/ascus.

Chemistry: Protocetraric acid and "amplior" unknown substances present.

Additional specimens: Same locality as the type, *M. E. Hale* 59,887 (US).

Observations: It is very close in external morphology and chemistry to *Myriotrema microstomum* (Müll. Arg.) Hale, a species from Japan which, however, has muriform spores and fumarprotocetraric acid in addition to protocetraric. *Ocellularia globosa* Hale from Sarawak has comparable anatomy and chemistry but with smaller spores, 8 – 10 × 30 – 50 μm, and a gaping pore up to 0.3 mm in diameter, through which the white pruinose disc is visible. It also has a more elaborate, fissurred white thallus.

Ocellularia inexpectata Nagarkar & Hale, sp. nov.

Thallus (Fig. 11) corticola, epiphloeodes, ca 5 cm latus; apothecia emergentia, plerumque basin constricta, 0.6 – 1 mm diametro, excipulo connato, fuligineo; columella fuliginea, 300 – 400 μm diametro; ostiolum rotundatum, 0.1 – 0.4 mm diametro; sporae fuscae, 8:nae, 9 – 10 × 22 – 24 μm, 6 – 8 × 1 – 2-loculatae.

Holotype: Sarawak, 30 km N of Sibu, Rasau logging area; in virgin peat dipterocarp forest: elev 1 m; 12 Mar. 1965; *M. E. Hale* 29,966 (US).

Thallus whitish mineral grey, minutely verruculose, fissured with age; cortex 10 μm, loose, indistinct; algal layer 15 μm, just above the bark surface, continuous or interrupted by crystals; medulla 20 – 25 μm, partly hypophloeodal, with medium-sized crystals; apothecia emergent, most basally constricted, 0.6 – 1 mm in diameter; exciple reddish brown, carbonized to the base; columella wide, 300 – 400 μm in diameter, 140 μm high, carbonized completely, with white pruinose tip visible through the pore, becoming actinoid; ostiole rounded, 0.1 – 0.4 mm in diameter, with concolorous pore area; margin verruculose, ca. 100 μm thick, with crystal-filled medulla; hymenium 120 μm high; spores brown, 6 – 8 × 1 – 2-loculate, 9 – 10 × 22 – 24 μm, I+ blue, 8/ascus.

Chemistry: "Praestans" unknown substances present.

Observations: Other *Ocellularia* species with an actinoid columella have much thicker thallii and different chemistry. *"Leptotrema" zollingeri*, the only other species in the genus with this chemistry, has small, immersed and ecolumellate apothecia.

Ocellularia kinabalensis Nagarkar & Hale, sp. nov.

Thallus (Fig. 12) corticola, epiphloeodes, 8 – 10 cm latus; apothecia congesta, emergentia, basin constricta, 0.6 – 1 mm diametro, excipulo connato, interiori fuligineo; columella fuliginea, 300 – 500 μm diametro; ostiolum rotundatum vel irregulariter elongatum, 0.2 – 0.35 μm diametro; hymenium 140 – 180 μm; sporae fuscae, 8:nae, muriformes, 6 – 8 × 12 – 20 μm, 1 × 4 – 5-loculatae.

Holotype: Sabah, Kinabalu National Park, small ridge just above E. Mesilau River; elev. ca 1900 m; Aug. 1964; *M. E. Hale* 28,245 (US).

Thallus pale greenish grey, distinctly verrucose, continuous; cortex indistinct; algal layer 30 – 40 μm, continuous or partly interrupted by crystals; medulla 35 – 90 μm, with medium-sized crystals; apothecia numerous, densely crowded, emergent, constricted at the base, 0.6 – 1 mm in diameter; exciple fused, reddish brown, with an incomplete layer of the bark cells, inner side thickly carbonized to the base; columella wide, 300 – 500 μm in diameter, 150 – 200 μm high, carbonized to the base, with a dome shaped white top up to 400 μm high, protruding out of the pore; ostiole circular to becoming irregularly elongated, 0.2 – 0.35 mm in diameter, opening out as an erect ring, sometimes up to 0.8 mm in diameter; margin verrucose, 200 – 280 μm thick; hymenium 140 – 180 μm high, confined to the periphery, ca. 140 μm thick; spores brown, muriform, 1 × 4 – 5-loculate, 6 – 8 × 12 – 20 μm, 8/ascus.

Chemistry: Psoromic acid present.

Observations: The columella has a very thick dome-shaped top which protrudes out through the pore as in the case of *O. berkeleyana* (Mont.) Zahlbr.) but here it is undivided. *Ocellularia cubana* (Tuck.) Zahlbr., has emergent large apothecia, wide pore and psoromic acid in the thallus, but the spores are smaller, only up to 12 μm long, and the columella is much thinner without protruding. Other psoromic acid-containing species of *Ocellularia* in this group have an actinoid columella.

Ocellularia pruinata Nagarkar & Hale, sp. nov.

Thallus (Fig. 13) corticola, epiphloeodes, 4–5 cm latus; apothecia emergentia, basin constricta, 0.4–0.9 mm diametro, excipulo connato; columella aetate actinoidea, ad 400 μm diametro; ostiolum rotundatum, 0.2–0.5 mm diametro; sporae incolores, 8:nae, 3–4 × 9–15 μm, transversim 4-loculatae.

Holotype: Malaya, State of Negri Sembilan, Kuala Pilah logging area, ca 10 km W of Kuala Pilah, felled trees in dipterocarp forest; elev. ca. 150 m ; 17 Aug. 1983; *M. E. Hale* 63,041 (US).

Thallus greenish to tannish grey, verruculose, continuous; cortex pale yellow, loosely cellular, 9–12 μm; algal layer 18–20 μm, continuous; medulla variable, 24–45 μm thick, with small crystal inclusions; apothecia solitary, emergent basally constricted at maturity, 0.4–0.9 mm in diameter; exciple fused, brown; columella present, initially wide, upto 400 μm, unevenly thickened, at length becoming actinoid, with white pruinose tip, brown; margin entire, becoming erect; pore gaping, 0.2–0.5 mm in diameter, filled with white tips of the columella; hymenium 90 μm high; spores hyaline, transversely 4-loculate, 9–15 × 3–4 μm, I + blue, 8/ascus.

Chemistry: Protocetraric acid and two unknown substances present.

Observations: *O. mauritiana* Hale and *O. auberianoides* (Nyl.) Nagarkar & Hale (comb. nov. Basionym: *Thelotrema auberianoides* Nyl., Ann. Soc. Scient. Fenn. 7:451. 1863). have an actinoid columella and protocetraric acid. *O. mauritiana*, however, has much larger apothecia, 1.5–3 mm in diameter and a carbonized exciple, while *O. auberinoides* has an irregularly elongate pore, a thicker thallus (up to 200 μm) and 6–8-loculate spores.

Ocellularia tuberculata Nagarkar & Hale, sp. nov.

Thallus (Fig. 14) corticola, epiphloeodes, tuberculo-papillatus, 4–6 cm latus; apothecia emergentia, basin constricta, 0.7–1.2 mm diametro, excipulo connato, apice fuligineo; columella apice fuliginea, 130–160 μm diametro; ostiolum rotundatum, 0.1–0.2 mm diametro; hymenium 200 μm; sporae incolores, 8:nae, 6–8 × 21–27 μm, transversim 8-loculatae.

Holotype: Malaya, Trail above (N of) Casino, Genting Highlands, just N of Kuala Lumpur; on small trees in elfin forest; elev. ca. 2000 m; 16 Aug. 1983; *M. E. Hale* 59,880 (US).

Thallus greyish sepia, with isidioid white tipped tuberculate papillae 288–320 × 252–272 μm, fissured; cortex 12 –15 μm, cellular, dark colored; algal layer diffused in a 48 μm thick epiphloeodal part of the thallus; medulla mostly hypophloeodal, with medium-sized crystals in the papillae and the margin; apothecia emergent, constricted at the base, columellate, 0.07–1.2 mm in diameter; exciple reddish brown, apically carbonized; columella simple, formed by the aggregation of hymenial elements, black at the tip with white pruina, 130–160 μm in diameter; margin distinctly verrucose, 200–216 μm; hymenium 200 μm; spores hyaline, transversely 8-loculate, 6–8 × 21–27 μm, I + blue, 8/ascus.

Chemistry: Hypoprotocetraric acid, 4-*O*-demethylnotatic acid, with or without psoromic acid.

Additional specimen: Malaya, State of Negri Sembian, Kuala Pilah logging area, *M. E. Hale* 63,082.

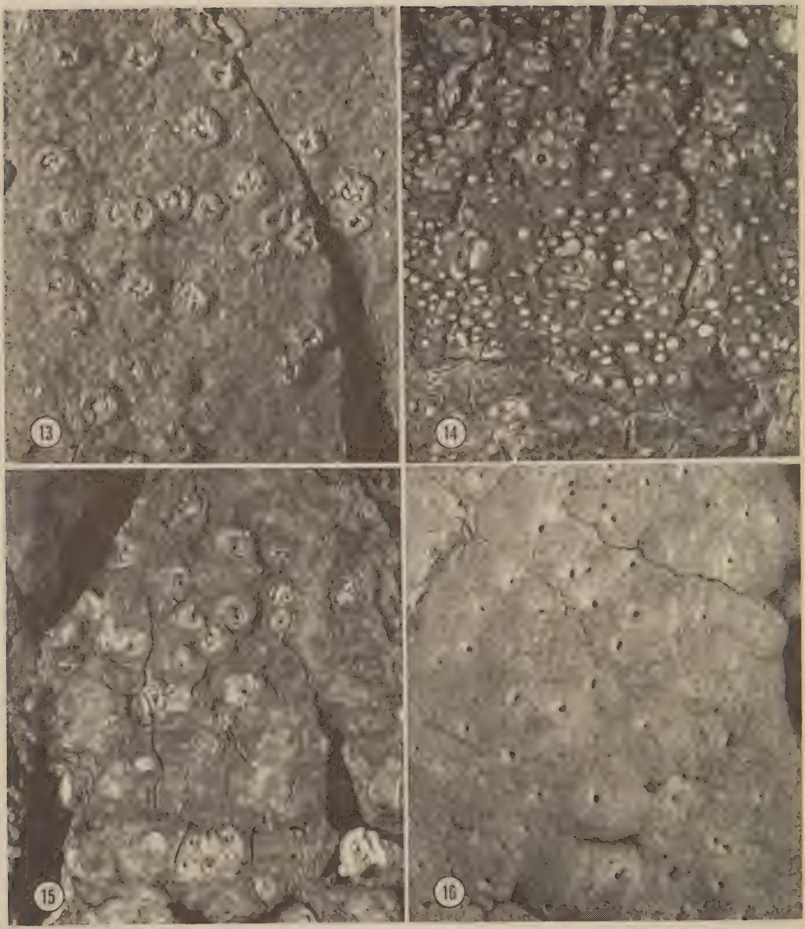
Observations: Conspicuous isidioid papillae and hypoprotocetraric acid make this a distinct species. *O. phaeotropa* (Krempel.) Müll. Arg. from Sarawak, with similar ascocarp structure and hypoprotocetraric acid in the thallus, lacks isidioid papillae. The type material has combination of hypoprotocetraric and psoromic acids, unusual for thelotremes.

Thelotrema fissuratum Nagarkar & Hale, sp. nov.

Thallus (Fig. 15) corticola, epiphloeodes, fissurina, 6–10 cm latus; apothecia semi-emergentia, 0.5–0.9 mm diametro, excipulo discreto; columella nulla; ostiolum rotundatum, albocinctum, 0.2–0.3 mm diametro; hymenium 145–155 μm; sporae incolores, 8:nae, 5–6 × 18–24 μm, transversim 8-loculatae.

Holotype: Malaya, State of Selanger, Genting Highlands; remnant mid-elevation rain forest; elev. ca 1800 m; 16 Aug. 1983; *M. E. Hale* 63,113 (US).

Thallus greenish olivaceous grey, smooth, shiny, deeply fissured; cortex thick, up to 45 μm,



Figures 13-16. Holotypes of *Ocellularia* and *Thelotrema* species: 13, *O. pruinata*; 14, *O. tuberculata*; 15, *T. fissuratum*; 16, *T. verruculosum*. See Fig. 4 for scale.

exfoliating, with aculeate hyphae; algal layer 24–30 μm, continuous; medulla 70–80 μm, with small dispersed crystals; apothecia semi-emergent, 0.5–0.9 mm in diameter; exciple free from the thalline wall, fissured to separate; pore area, rim and excipular tips white; pore 0.2–0.3 mm in diameter; hymenium 145–155μm high; spores hyaline, transversely 8-loculate, 5–6 × 18–24 μm, I + blue, 8/ascus.

Chemistry: Psoromic acid present.

Observations: Inner and outer excipular tissues are fused but due to cracking they are seperated from rest of the thallus. Hyphal tips of the inner exciple appear to be periphyses at the lower magnifications. The species has no close relatives in the genus.

Thelotrema verruculosum Nagarkar & Hale, sp. nov.

Thallus (Fig. 16) corticola, epiphloeodes, 6–8 cm latus; apothecia immersa, 0.25–0.4 mm diametro, exciplo connato; columella nulla; ostiolum profunde depressum, albocinctum, 0.1–0.2 mm diametro; hymenium 140–200 μm; sporae fuscae, 8:nae, 10–12 × 12–15 μm, 2 × 2–3-loculatae.

Holotype: Malaya, State of Negri Sembilan, Kuala Pilah logging area, ca 8 km N of Seremban-Kuala Pilah road, ca 10 km W of Kuala Pilah, on felled trees in dipterocarp forest; elev. ca 150 m; 17 Aug. 1983; *M. E. Hale* 63,057 (US).

Thallus whitish mineral grey, smooth to minutely verruculose, continuous; cortex ca. 10 μm; algal layer 30–35 μm, interrupted by crystals; medulla thick, up to 320 μm, with medium-sized crystals; apothecia numerous, immersed in the medulla, 0.25–0.4 mm in diameter; the exciple fused, reddish brown, darker towards inner edge, with long periphysoids; pore deeply depressed, white rimmed, 0.1–0.2 mm in diameter; hymenium 140–200 μm; spores brown, broadly oval, 2 × 2–3-loculate, 10–12 × 12–15 μm, 8/ascus.

Chemistry: No substances present.

Observations: Depressed pores, long periphysoids, and 2 × 2–3-loculate broadly oval spores distinguish this species. It has no close relatives in the genus.

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PHYTOPHTHORA UNDULATA COMB.NOV.

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Phytophthora undulata (H.E. Petersen) M.W. Dick comb.nov.

Basionym	*Pythium undulatum* H.E. Petersen, *Botanisk Tidsskrift* **29**: 345 (1909).
Synonyms	*Pythiomorpha undulata* (H.E. Petersen) A.E. Apinis, *Acta Horti Botanici Universitatis Latviensis* **4**: 234 (1929). *Pythium undulatum* H.E. Petersen var. *litorale* Hohnk, *Veroffentlichungen des Instituts fur Meeresforschung in Bremerhaven* **2**: 81 (1953).

Type: IMI 308280 (NEOTYPE). Plaats-Niterink (1981) quotes a culture as the neotype. This does not satisfy the *International Code of Botanical Nomenclature* (Greuter *et al.*, 1988) and therefore slides of culture IMI 308280 have been deposited in Herb. IMI, Isoneotypes at Reading.

Pythium undulatum H.E. Petersen was first described from Denmark (Petersen, 1909). Apinis (1929) transferred the species to *Pythiomorpha* H.E. Petersen. The fungus is common in the northern hemisphere and has been studied on various occasions from N. America (Beneke & Schmitt, 1961; Dick, 1971 (Canada, B.C.); Drechsler, 1946; Goldie-Smith, 1952; Hamm *et al.*, 1988 (Alaska);

Matthews, 1931; Scott, 1960 (Haiti); Sparrow, 1932) Europe (Apinis, 1929; Beverwijk, 1948; Dissman, 1927; Dudka, 1970 (Ukraine); Goldie-Smith, 1952; Hohnk, 1953, 1956; Johnson, 1971 (Iceland); Lund, 1934; Perrott, 1960; Petersen, 1909, 1910; Wildeman, 1931; Zebrowska, 1976) and Asia (Khulbe & Bhargava, 1977, India). It does not appear to have been reported from the southern Hemisphere.

No sexual reproduction has ever been obtained, so the generic disposition of this taxon has rested on the morphology of the zoosporangium, which is acknowledged to be exceptional (Plaats-Niterink, 1981). The zoospore cyst diameter is also at the upper end of the range for *Pythium.* It is pertinent to note from the discussion in Plaats-Niterink (1981) that zoospores are known to be formed within the sporangium on occasion, and that it was this feature that Apinis (1929) used to justify the transfer of the species to *Pythiomorpha.* Goldie-Smith (1952: plate 24, fig. 10) gives unequivocal proof of this phenomenon and also points out that there is no discharge tube. *Pythiomorpha* is regarded as a synonym of *Phytophthora* (Blackwell, Waterhouse & Thompson, 1941). Beneke & Schmitt (1961) used the combination "*Phytophthora undulatum* (*Pythiomorpha undulata*)" without comment regarding the nomenclature.

Belkhiri & Dick (1987) cast some doubt on the position of *Pythium undulatum* within the genus *Pythium* because it failed to show the characteristic ribosomal DNA band in DNA preparations. Work on the comparative tolerance of a wide range of Oomycetes to hymexazol concentrations (Kato & Dick, in preparation) has shown that the responses of *Phytophthora undulata* were unlike those of *Pythium* species but did resemble those for several species of *Phytophthora.* Therefore it is now appropriate to make the new combination which was first intimated, on other grounds, by Apinis (1929). Unfortunately, Apinis (1929) used the genus *Pythiomorpha.* However, since the type species of *Pythiomorpha* (*P. gonapodyides* H.E. Petersen) was transferred to *Phytophthora* (*P. gonapodyides* (H.E. Petersen) C.J. Buisman) by Buisman (1927) and Blackwell *et al.* (1941) placed *Pythiomorpha* as a synonym of *Phytophthora* without mention of *Pythium undulatum* or *Pythiomorpha undulata*, a new combiantion is required.

Dick (Belkhiri & Dick, 1988; Dick *et al.*, 1989) has suggested that supra-specific taxa in both *Pythium* and *Phytophthora* may need reconsideration. Many more chemotaxonomic data will be required before morphological criteria can be suitably redefined to reflect relatedness. The change proposed here relates to *Pythium sensu lato* and *Phytophthora sensu lato.*

Phytophthora gonapodyides is another species of *Phytophthora* which has no known sexual reproduction and which shares with *P. undulata* an aquatic saprophytic habit. However, there are no data to suggest that these two species are closely related within *Phytophthora sensu lato.* Therefore, it would not be appropriate to revive the genus *Pythiomorpha,* which was originally erected for *P. gonapodyides* by Petersen (1909).

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CONCERNING ATKINSONELLA TEXENSIS, A PATHOGEN OF THE GRASS STIPA LEUCOTRICHA: DEVELOPMENTAL MORPHOLOGY AND MATING SYSTEM.

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ABSTRACT

Atkinsonella texensis (Diehl) Leuchtmann and Clay in ed., a member of the Balansieae host-specific to *Stipa leucotricha* Trin., is described and illustrated. The developmental morphology of the teleomorph and the preceding synanamorphs [microconidial *Acremonium*-like state and macroconidial *Ephelis* state] are considered. The fungus is shown, by experimental crosses, to be heterothallic. Comments are made on the similarity between the microconidial anamorph and that of *Epichloë typhina* (Fr.) Tul. [*Acremonium typhinum* Morgan-Jones & W. Gams].

INTRODUCTION

In recent years, fungi belonging to the tribe Balansieae [Clavicipitaceae, Claviciptiales, Ascomycotina], associated with grasses, have been shown to have a significant impact on the ecology of their hosts and some have been found to cause frequent and severe toxicosis in cattle (Bacon *et al.*, 1975, 1986; Lyons *et al.*, 1986). Infected grasses are now thought to be resistant to numerous insect herbivores due to the production of toxic alkaloids by these fungi, or by the hosts in response to their presence (Funk *et al.*, 1983; Siegel *et al.*, 1985; Clay, 1986, 1988). The Balansieae was monographed by Diehl (1950), who adopted generic concepts reflective of anamorph characteristics as well as teleomorph morphology. The genus *Atkinsonella* Diehl was established to accommodate *A. hypoxylon* (Peck) Diehl [*Epichloë hypoxylon* Peck], on the basis of the presence in its life-cycle of a so-called typhodial anamorph [an adjective derived from the form-genus *Typhodium* Link, a name sometimes used, in the past, for the anamorph of *Epichloë* (Fr.) Tul.] in addition to the ephelidial anamorph [belonging to *Ephelis* Fr.] typical of the genera *Balansia* Speg. and *Myriogenospora* Atk. *Atkinsonella hypoxylon* had previously been classified in *Balansia* [as *B. hypoxylon* (Peck) Atk.] and in *Hypocrella* Sacc. [as *H.*

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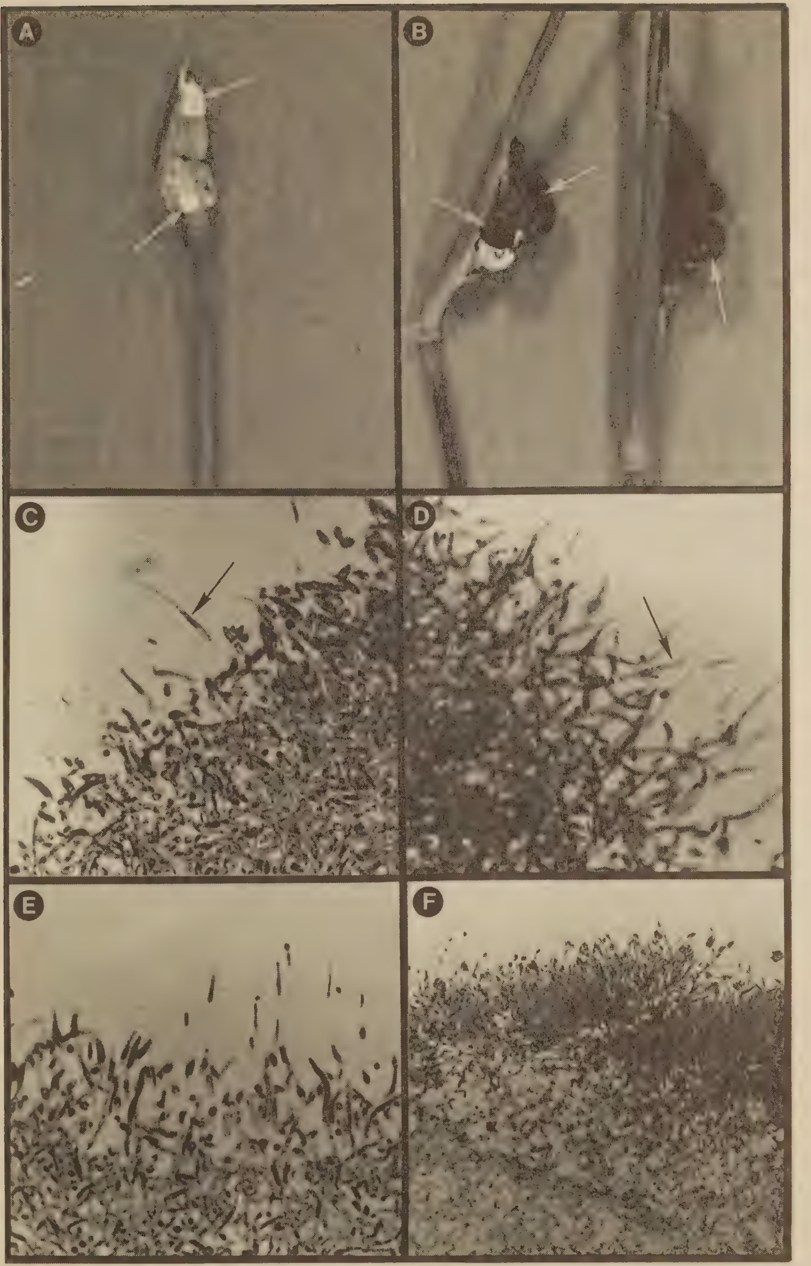
hypoxylon (Peck) Sacc.]. Binomial recombinations had also been made into *Dothichloë* Atk., *Hypocrea* Fr. and *Ophiodothis* Sacc. [*D. hypoxylon* (Peck) Atk., *H. hypoxylon* (Peck) Ell. & Everh., and *O. hypoxylon* (Peck) Sacc., respectively]. These, however, as recognized by Diehl (1950), were purely nomenclatural shuffles since each authority had misidentified the fungus on which they based their recombination decisions. In each instance, *Balansia henningsiana* (Moell.) Diehl [*Ophiodothis henningsiana* Moell.] had been erroneously determined as *Epichloë hypoxylon*. Both *Dothichloë* and *Ophiodothis* are now, incidentally, considered to be synonyms of *Balansia*. The binomial *Ephelis borealis* Ell. & Everh. was established for the ephelidial anamorph of *A. hypoxylon* (Ellis and Everhart, 1885).

The presence or absence of one or other of the two anamorphs helps characterize all genera of the Balansieae, namely *Atkinsonella*, *Balansia*, *Balansiopsis* Höhn., *Epichloë* and *Myriogenospora*. In *Epichloë*, only the microconidial, typhodial anamorph [now classified in *Acremonium* Link, sect. *Albo-lanosa* Morgan-Jones & W. Gams (Morgan-Jones and Gams, 1982; White and Morgan-Jones, 1987b)] is present, whereas in *Balansia* and *Myriogenospora* only the macroconidial, ephelidial state is produced (Rykard *et al*., 1984). Diehl (1950) reported that no anamorph is produced in *Balansiopsis* but Rykard *et al*. (1984) documented the occurrence of small discoid cavities in the stroma of *Balansiopsis pilulaeformis* (Berk. & Curt.) Diehl, lining which are *Ephelis* conidiophores. So far as is known, however, an anamorph is lacking in *B. gaduae* (Rehm) Höhn. [*Ophiodothis gaduae* Rehm], the type species of *Balansiopsis*, and in *B. asclerotiaca* (P. Henn.) Diehl. In *Atkinsonella*, the typhodial anamorph is the first to be formed and originates from an ectostroma in the same manner as in *Epichloë*. Individual conidiogenous cells, in a loose palisade, each producing a single conidium holoblastically, have the subulate form characteristic of *Acremonium typhinum* Morgan-Jones & W. Gams [anamorph of *E. typhina* (Fr.) Tul., the type species of *Epichloë*]. The *Ephelis* state subsequently develops beneath the microconidial layer, occupying cavities within the stroma or becoming erumpent and sporodochium-like.

The generic name *Typhodium* is a *nomen dubium* because it cannot be satisfactorily typified. As pointed out by Diehl (1950), Link's meager description of it suggests a stage in stromatic development where immature perithecia are present. *Typhodium* is therefore probably a facultative synonym of *Epichloë* (Clements and Shear, 1931; Ainsworth, 1971; Rykard *et al*., 1984) and is not available for the anamorph. Another form-genus, *Sphacelia* Lēv., [type species *S. segetum* Lēv., the anamorph of *Claviceps purpurea* (Fr.) Tul.] has also been taken up for the microconidial typhodial state following the naming of the anamorph of *Epichloë typhina* as *Sphacelia typhina* (Pers.) Sacc. and *Sphacelia typhina aeruginosa* Sacc. (Saccardo, 1881, 1882, respectively) [*Sphacelia typhina* Sacc.]. The binomial *S. typhina* is, however, also regarded as a *nomen dubium* since it is uncertain that Saccardo ever saw the true anamorph of *E. typhina*, as explained by Morgan-Jones and Gams (1982) and by

PLATE 1. *Atkinsonella texensis*. A, Primary conidial stroma showing white mycelial growth (indicated by arrows) where stromata of opposite mating type were rubbed; B, primary stromata, each bearing a number of black, pulvinate, more or less hemispherical ascostromata (indicated by arrows); C-E, sections through microconidial stromata (conidiogenous cells indicated by arrows) [X 4000]; section showing superficial, macroconidial, sporodochium-like *Ephelis* pustule [X 1000].


A
B
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White and Morgan-Jones (1987b). Saccardo, in his 1882 account, may, in fact, have based his observations on discordant elements: a greenish [etym. : *aerugo*, the rust of copper] fungus overgrowing the stromata of *Epichloë*. The continued use of *Sphacelia* as a generic name for the anamorph of *Epichloë* is unfortunate for several additional reasons. The sphacelial anamorph of *C. purpurea* is appreciably different in morphology from that of *Epichloë*. In the former, short, obclavate conidiogenous cells, arranged in a dense, effuse palisade, are borne in convoluted labyrinthine chambers (Luttrell, 1980). Moreover, conidiogenesis in *Sphacelia segetum* is enteroblastic, a number of glutinous conidia being formed from each phialidic conidiogenous cell. In addition, the fact that *Sphacelia*, is the anamorph of *Claviceps*, which constitutes the tribe Clavicipiteae, should preclude its use for conidial *Epichloë*. By the same token, it is inappropriate to refer to the microconidial state of *Atkinsonella* as being sphacelial or belonging to *Sphacelia* as is sometimes done in the literature.

Diehl's (1950) treatment of the Balansieae focuses predominantly on morphological aspects observed by study of herbarium material and is incomplete in so far as details of development and life history are concerned. A modern treatment of species of Balansieae, including studies of biological aspects such as mating systems, stromal development, and infection mechanisms, would contribute significantly to our understanding of the group. When Diehl (1950) described *Atkinsonella hypoxylon*, a pathogen of species of the grass genus *Danthonia* DC., a separate variety, occurring on *Stipa leucotricha* Trin., was recognized and named *A. hypoxylon* var. *texensis*. The autonym *A. hypoxylon* var. *hypoxylon* was thereby created. Variety *texensis* had previously been reported by Heald and Wolf (1912) [as *Balansia hypoxylon*] to be the causal organism of a "Balansia blight" disease which destroyed the grass inflorescence. Variety *texensis* was said to differ (Diehl, 1950) in having larger stromata and ephelidial conidiomata. Following reevaluation of the characteristics of var. *texensis*, Leuchtmann and Clay (1989) concluded that this entity differs sufficiently from *A. hypoxylon* var. *hypoxylon* to warrant recognition as a separate species. In addition to stromal size disparity, differences were found in the morphology of the conidiomata of its *Ephelis* anamorph and in growth rates and colony characteristics *in vitro*. Inoculation experiments showed the two entities to be host specific to their respective grass genera and isoenzyme studies indicated appreciable genetic distance between the two. The present authors concur with the view that var. *texensis* should be elevated to species rank. We have had opportunity to examine fresh collections of *A. texensis* and to conduct an investigation of its mating system. The results of our studies of its developmental morphology and crossing experiments are reported herein.

MATERIALS AND METHODS

Stromata of *A. texensis*, in various stages of development, were collected at the Brackenridge Field Experiment Station, University of Texas at Austin. For histological studies, stromata were cut into disks, approximately 2 mm thick. These were fixed in FAA [5 parts formalin: 5 parts concentrate acetic acid: 90 parts 95% ethanol], dehydrated in a graded ethanol series and embedded in acrylic embedding medium [LR White]. Sections approximately 1 um thick were made using glass knives and stained in warm [50 C] 1% aqueous aniline blue stain followed by 1% aqueous toluidine blue.

To investigate the mating system of the fungus, crosses were made in the laboratory between randomly collected stromata. Culms of nine separate plants,

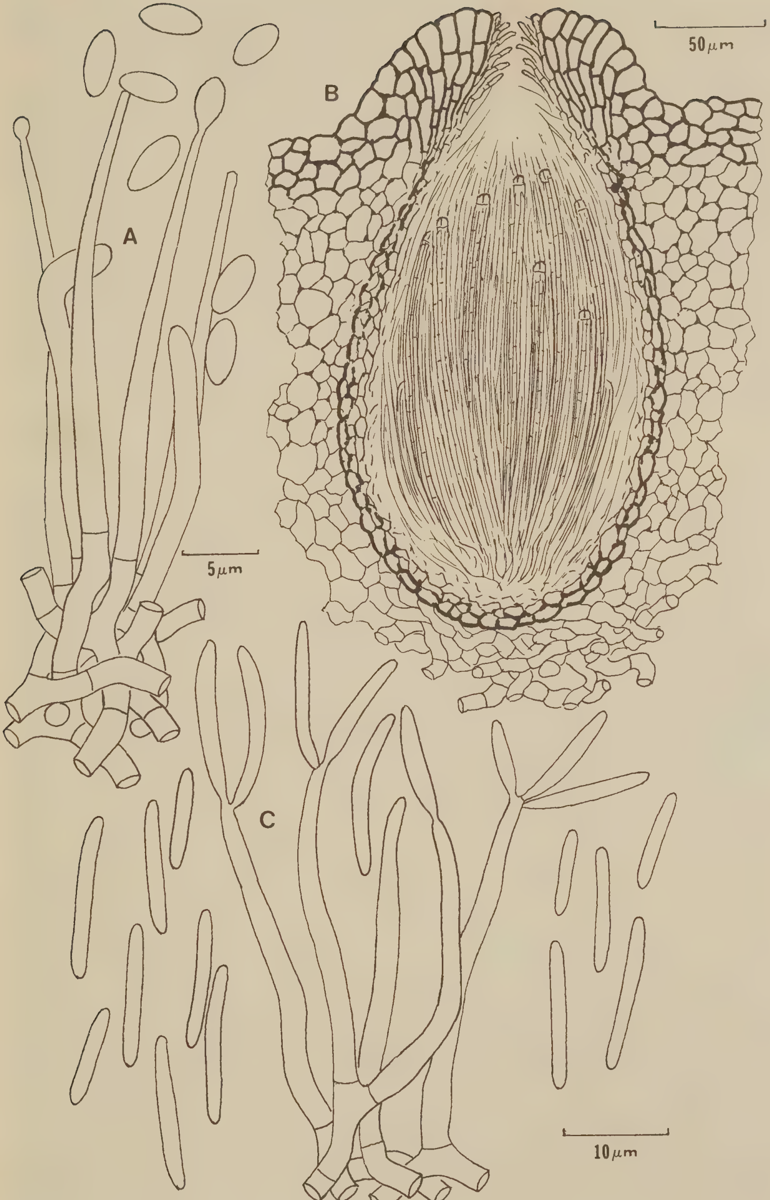

A
B
C
50µm
5µm
10µm

FIGURE 1.*Atkinsonella texensis*. A, *Acremonium*-like microconidial state and receptive hyphae; B, V.S. perithecium; C, *Ephelis* macroconidial state.

each with newly-formed stromata bearing microconidia, were selected. Each was cut 7 inches below the stroma using a sharp razor and placed separately into 50 ml test tubes containing distilled water. Stromata were then segregated into three groups [designated A, B, and C arbitrarily], each group consisting of three stromata [designated 1, 2, and 3]. To make crosses within each group, stromata were inoculated with both of the other stromata by bringing them into contact as follows: to inoculate stroma 1, stroma 2 was brushed against its top, and stroma 3 was brushed against its bottom; to inoculate stroma 2, stroma 1 was brushed against its top, while stroma 3 was brushed against its bottom; to inoculate stroma 3, stroma 1 was brushed against its top, and stroma 2 was brushed against its bottom. In this way, all possible crosses were made within each of the three groups of stromata. Stromata were then loosely wrapped in plastic bags to prevent drying and incubated at room temperature for one week, after which time each was examined for evidence of ascostromal initiation. Growth of a white raised mycelium over the surface of the inoculation site (Fig. 1) was taken as evidence that stromata brought into contact were of the opposite mating type and no response indicated the cross-inoculated stromata to belong to the same mating type.

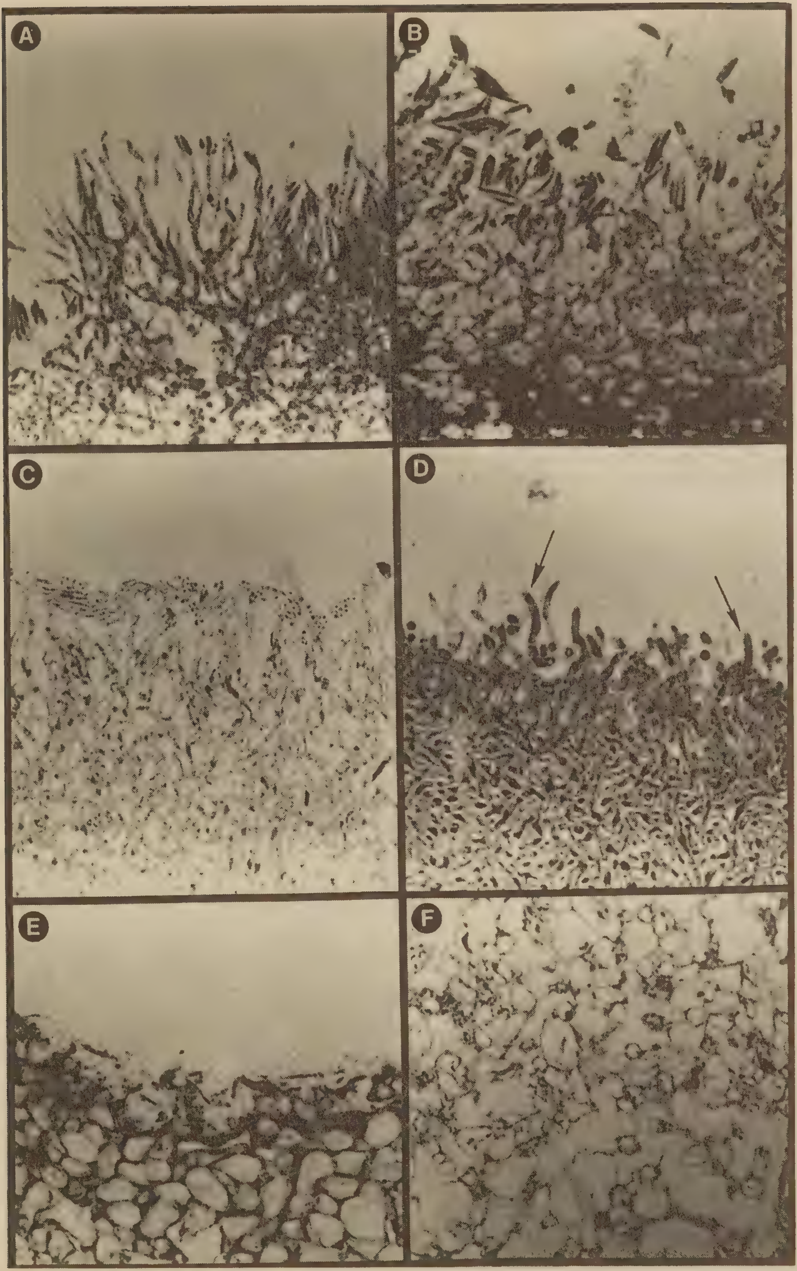
TAXONOMIC PART

Atkinsonella texensis (Diehl) Leuchtmann and Clay, *Mycologia* 80: 1989, *ineditatio* (Plates 1, 2 & 3, Figure 1).

≡ *Atkinsonella hypoxylon* (Peck) Diehl, var. *texensis* Diehl, *U.S.D.A. Agr. Monogr.* 4: 54, 1950.

Mycelium at first occurring epiphytically in the vicinity of upper leaf bases, then progressively enveloping culm and immature inflorescence, with some hyphae becoming intercellular and associating with phloem tissue, eventually consolidating to form a compact, initially prosenchymatous stroma. Stromata (Plate 1, A & B) surrounding and eventually enclosing inflorescence, but not the leaf, at first white, becoming gray to purple gray, more or less obclavate in shape, surface uneven with scattered pulvinate protrusions, at first linear within the leaf sheath, later becoming exposed and bent outwards towards its middle, away from the leaf, to give a boomerang-like configuration (Plate 1, B), 9-18 X 2-5 mm in size, attenuated distally. Surface stromal protrusions 1-1.5 mm in diameter reflective of underlying ovules and associated tissues or, when larger, of secondary ascostromal development. Microconidial conidiophores arising from hyphae at the exposed periphery of young stromata, more or less evenly distributed over the entire stromal surface arranged in a loose, effuse palisade, oriented perpendicular to the surface, simple or occasionally branched, usually somewhat flexuous, cylindrical, septate, hyaline, thin-walled. Microconidial conidiogenous cells (Plate 1, C-E) terminal, determinate, attenuating distally to give a subulate shape, straight or slightly curved, slender, bearing a single conidium and lacking terminal periclinal thickening, 18-25 µm long, 1-2 µm wide at the base. Microconidia holoblastic,

PLATE 2. *Atkinsonella texensis*. A & B, *Ephelis* conidiogenous cells and macroconidia [X 4000]; C, expanding stroma below ephelidial layer [X 2000]; D, consolidated stroma following fertilization, with some receptive hyphae [indicated by arrows] still apparent; [X 4000] E, section of ascostromal surface layer showing pseudoparenchymatous, melanized tissue; F, tissue toward center of ascostroma [X 4000].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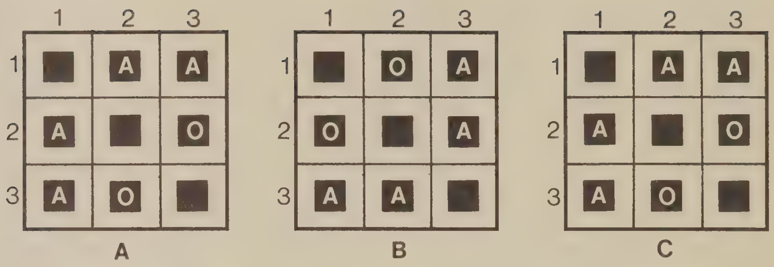


	1	2	3
1	■	A	A
2	A	■	O
3	A	O	■

A

	1	2	3
1	■	O	A
2	O	■	A
3	A	A	■

B

	1	2	3
1	■	A	A
2	A	■	O
3	A	O	■

C

FIGURE 2. A - C, Results of three separate sets of crosses [labelled A, B, and C] between randomly collected stromata [labelled 1, 2, and 3], (A = ascostromal initiation; O = no ascostromal initiation). A series of crosses: crosses between stromata 1 and 2, and 1 and 3 resulted in ascostromal initiation, while crosses between stromata 2 and 3 showed no reaction. B series of crosses: crosses between stromata 1 and 3, and 2 and 3 resulted in ascostromal initiation, while crosses between stromata 1 and 2 showed no reaction. C series of crosses: results were identical to those in the A series of crosses.

ellipsoidal or narrowly ovoid, hyaline, unicellular, smooth, thin-walled, 3-4.5 X 1-2 µm. Microconidial conidiophores interspersed with somewhat shorter, sterile, determinate hyphae, oriented in the same direction, whose obtuse tips are free and exposed. Macroconidial [*Ephelis*] conidiomata arising as cavities in the stromata and becoming erumpent from below the primary microconidial hymenium, or frequently originating superficially as scattered sporodochium-like pustules (Plate 1, F), white to gray in color, sometimes overlying young ascostroma. Macroconidial conidiophores arranged in a loose to dense palisade, cylindrical, septate, branched (Plate 2). Macroconidial conidiogenous cells cylindrical, straight or somewhat flexuous, attenuating gradually toward the apex, sympodial, 1-2.5 µm wide, varying in length, gently geniculate at the apex and bearing the macroconidia in verticil-like clusters. Macroconidia holoblastic, narrowly cylindrical to acicular, straight or very slightly curved, unicellular, smooth, thin-walled, 8-23 X 1-1.5 µm, appearing as glutinous, cream-colored masses extruding from stromal cavities or overlying the sporodochium-like conidiomata (Plate 2, B). Ascostromata hemispherical or somewhat flattened (Plate 3, A), pulvinate, arising as a number of separate entities from the primary conidial stroma, originating, following fertilization, by consolidation and subsequent expansion from just below the palisade of microconidial conidiogenous cells, becoming erumpent and exposed, when mature black in surface view, remaining pale within, 0.5-3 mm in diameter, 1-2 mm high, surface minutely papillate in the vicinity of slightly protruding perithecial necks. Ascostromal tissue at the exposed surface, and in a narrow zone below, pseudoparenchymatous, composed of thick-walled, melanized, inflated, more or less isodiametric cells (Plate 2, E); paler but also pseudoparenchymatous in the subtending portion containing perithecia; and looser, prosenchymatous toward the center and base, tending to disintegrate somewhat centrally as perithecia mature (Plate 2, F). Perithecia immersed, arranged in an irregular layer a short distance below the ascostromal surface (Plate 3, B), lageniform, with a short, thickened, periphysate neck, gregarious, not or very slightly compressed (Plate 3, D), 200-400 µm long, 100-200 µm wide. Perithecial wall well-defined, pseudoparenchymatous (Plate 3, E), generally composed of smaller, more elongate cells than the surrounding stromal tissue. Asci cylindrical with thickened apex pierced by a narrow, tubular pore (Plate 3, F), eight-spored, 120-250 X 4-6 µm. Ascospores filiform, hyaline, multiseptate, 100-190 X 1-1.5 µm.

On *Stipa leucotricha* Trin.; North America.

Collection examined: Brackenridge Field Experiment Station, Austin, Texas, May 1987, J.F. White Jr., AUA.

RESULTS AND DISCUSSION

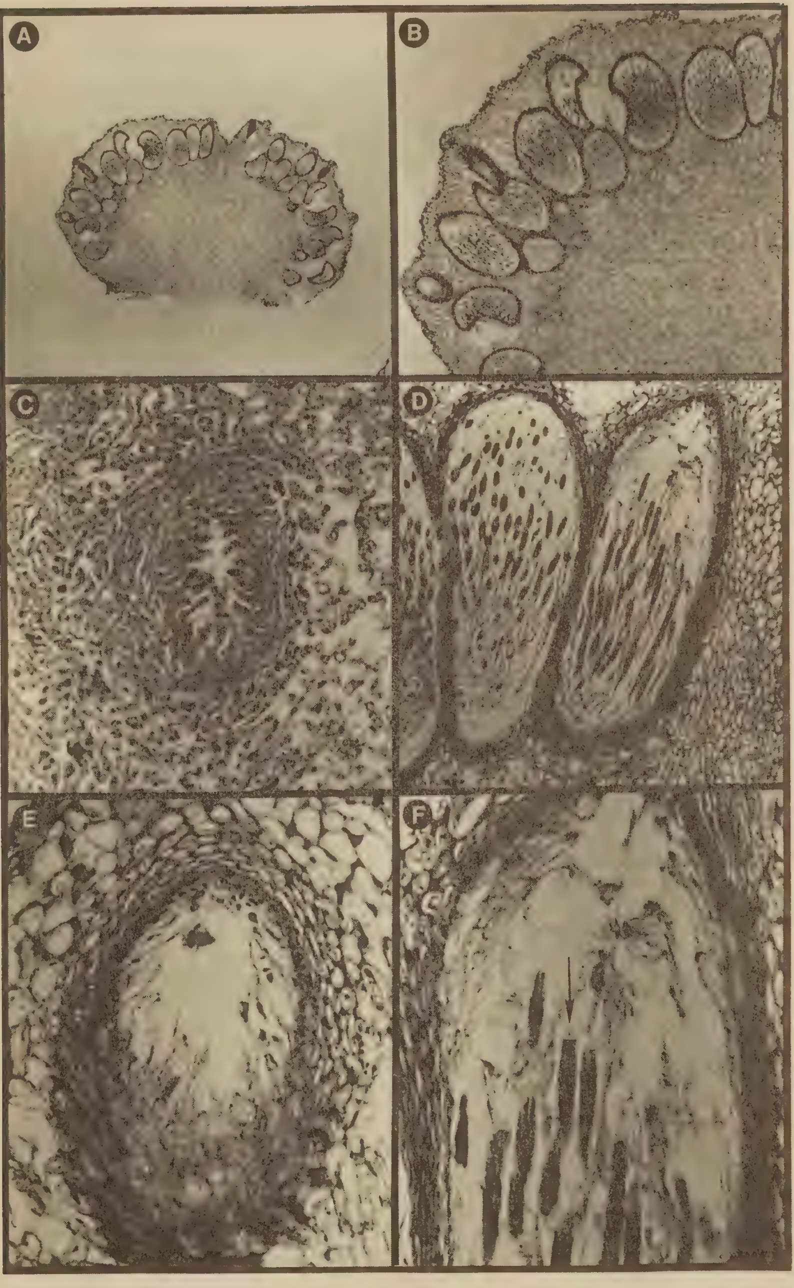
The results of crossing experiments (Fig. 2) suggest *Atkinsonella texensis* to be self-incompatible and heterothallic, with two mating types. For initiation of the sexual phase and elaboration of an ascostroma, a primary conidial stroma must be cross-inoculated with a microconidium of the opposite mating type. The microconidia, although they have capacity to germinate, function as spermatia. In nature, these are assumed to be wind-transmitted (Diehl, 1950). In *Epichloë typhina*, which is also heterothallic (White and Bultman, 1987), microconidia, serving as spermatia, are carried by insects between stromata (Bultman and White, 1987). Whether or not insects play a similar role in the case of *A. texensis* is presently unknown. The sterile, temporarily determinate, hyphae intermixed with microconidial conidiogenous cells probably function as trichogynes or receptive elements, as they are assumed to do in *E. typhina* (White and Morgan-Jones, 1987b). Such hyphae in *A. texensis* resemble those of *E. typhina* in frequently becoming curved subapically so as to assume, toward their tip, orientation more or less parallel to the stromal surface. Some of these initially sterile hyphal elements may, however, remain linear and give rise to further conidiogenous cells so that a succession of these are, in effect, produced. Following fertilization, hyphal growth is resumed laterally in-between and over the microconidial hymenium, mycelial proliferation giving rise to the pulvinate, compact, largely pseudoparenchymatous ascostroma. In our experimental crosses, abundant white mycelium developed at the sites of inoculation when compatible pairings were made. The abundance of such mycelium probably indicated multiple fertilization, resulting in stimulation of many hyphae to resume growth following dikaryotization. The provision of favorable environmental conditions also undoubtedly contributed to appreciable mycelial growth during the one-week incubation period. In nature, the ephelidial anamorph succeeds the microconidial state, forming predominantly as small, scattered pustules superimposed over the primary stroma or immature ascostroma, or originating within cavities in the loosely organized primary stroma. Stromata of *A. texensis* frequently become overgrown in nature by colonies of *Cladosporium* spp., giving them a greenish coloration. In this connection it is interesting to note that Sampson (1933) reported the perithecial layer in *Epichloë typhina* to dry following ascospore dispersal and to become moldy with *Cladosporium* sp.

A number of morphological differences exist between *Atkinsonella hypoxylon* and *A. texensis*. The stromata of the latter, as noted by Diehl (1950), tend to be larger and no leaf tissue is encompassed within them. The ephelidial conidiomata in *A. hypoxylon* are saucer-shaped or apothecioid, in contrast to those of *A. texensis* which are mostly sporodochium-like, and the macroconidia of the latter are appreciably shorter [those of *A. hypoxylon* measure 14-40 X 1-1.5 µm] (Leuchtmann and Clay, 1989; Morgan-Jones and White, personal observations). It should be noted, however, that ephelidial conidiomata tend to be quite variable. Ullasa (1969) described the *Ephelis* anamorph of *Balansia claviceps* Speg. [*Ephelis mexicana* Fr., the type species of *Ephelis* according to

Diehl (1950)] to have conidiomata that vary in outline, and their morphology to be dependent upon the nature and moisture content of the host tissue. Rykard *et al.* (1984) also considered *Ephelis* to be a variable genus, although typically having an apothecioid conidiomata. They noted that the conidiomata of *Atkinsonella hypoxylon* originate as pustular swellings containing a saucer-shaped locule overlaid by stromatic tissue. A layer of conidiophores lining the base of the locule is exposed by splitting of the overlying tissue which is pushed sideward to assume the form of an exciple. The microconidial conidiogenous cells in *A. texensis* are more slender and more aculeolate in overall shape than those of *A. hypoxylon*. In this respect, they resemble those of *Acremonium typhinum in vivo* (see White and Morgan-Jones, 1987b). Those of *A. hypoxylon* measure 2.5-3.5 µm wide at the base and attenuate abruptly distally to give a narrowly lageniform shape. Further documented differences between *A. hypoxylon* and *A. texensis* (Leuchtmann and Clay, 1989) include colony coloration, texture, and growth rate *in vitro*. Also, host inoculation studies by these authors showed the two species to be host-specific to their respective grass genera.

Cell wall relationships between microconidia and the conidiogenous cells from which they originate in *A. texensis* are, at present, uncertain, as in the case in *Acremonium typhinum* and in the other endophytic fungal anamorphs classified in *Acremonium* sect. *Albo-lanosa*. As indicated by White and Morgan-Jones (1987b), conidia in *A. typhinum* are thought to be possibly produced holoblastically, but ultrastructural studies are necessary in order to determine this. Likewise we are, therefore, referring to the process of microconidiogenesis in *A. texensis* as being holoblastic advisedly. The conidiogenous cells of the endophytes *Acremonium coenophialum* Morgan-Jones & W. Gams, *A. lolii* Latch, Christensen & Samuels and *A. typhinum*, as discussed by Latch *et al.* (1984) and White and Morgan-Jones (1987b), at least do not appear to be typical phialides. There is no periclinal thickening at the apex, which is not flared and has the appearance, under the light microscope, of being closed. In this respect, the conidiogenous cells seem to bear similarity to those of species of *Cladobotryum* Nees (see Gray and Morgan-Jones, 1980). Rykard *et al.* (1984) considered the conidiogenous cells of the anamorphs of *E. typhina* and *A. hypoxylon* [referred to as *Sphacelia* states] to be phialidic. The so-called typhodial, microconidial state in the *Atkinsonella* life-cycle is homologous with the *Acremonium* anamorph [*A. typhinum*] in *Epichloë typhina*. Moreover, the organization of the microconidial stromata and the morphology of the microconidial conidiogenous cells in the two are quite closely similar, indicating phylogenetic affinity. Because of this, the microconidial state in *A. texensis* can, at least provisionally, be referred to as being *Acremonium*-like, or as the *Acremonium* anamorph of *A. texensis*. In due course, following further studies of endophytic anamorphs belonging to this complex, it may well be appropriate to establish a separate form-genus in which to accommodate anamorphs currently classified in *Acremonium* sect. *Albo-lanosa* and the microconidial states of *A. hypoxylon* and *A. texensis*. In the meantime, as alluded to in the introduction, application of the generic name *Sphacelia* to the latter should be avoided. The microconidia of *Acremonium typhinum* and some

PLATE 3. *Atkinsonella texensis*. A & B, section of ascostroma bearing perithecia [A, X 200; B, X 800], C, early stage of perithecial formation in expanding ascostroma [X 4000]; D, V.S. perithecia [X 2000]; E, section of young perithecium showing anatomy of perithecial wall; F, asci with thickened apices (narrow, tubular pore indicated by arrow) [X 4000].


A
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other endophytic members of sect. *Albo-lanosa*, such as *A. coenophialum* and *A. starrii* White & Morgan-Jones, differ from those of *A. texensis* in being inequilateral. This is not, however, considered to be significant at generic level since *Acremonium chisosum* White & Morgan-Jones, an endophyte of *Stipa eminens* Cav. not known to have an extant teleomorph, classified in sect. *Albo-lanosa* (White and Morgan-Jones, 1987c), has ovoid microconidia (see White and Morgan-Jones, 1987a), not dissimilar to those of *A. texensis*.

In perpetuating the use of the generic name *Atkinsonella*, Leuchtmann and Clay (1988a, 1988b, 1989) chose to disregard the view of Rykard *et al.* (1984) that there is little justification for maintaining it as a separate entity from *Balansia*. With the recognition of the second species, *A. texensis*, having the characteristic of possessing both microconidial *Acremonium*-like and macroconidial *Ephelis* anamorphs, we, likewise, accept, for the time being at least, the generic distinctions drawn by Diehl (1950). Similarly, we believe that *Balansiopsis* should be maintained until the peculiarities of its type species, *B. gaduae*, particularly whether or not it bears an *Ephelis* anamorph, can be fully reevaluated from fresh collections. Ideally, a new and comprehensive study of these fungi should be conducted before considering reamalgamation of some of the taxa presently separated at generic level.

ACKNOWLEDGMENT

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NEW SPECIES AND NEW RECORDS OF HYPOGYMNIA (LICHENIZED ASCOMYCOTINA)

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ABSTRACT : The species *Hypogymnia australica* Elix and *Hypogymnia tasmanica* Elix are described as new. The new combination *Hypogymnia pectinatula* (Zahlbr.) Elix is made; *H. pseudobitteriana* (Awas.) Awas. and *H. zeylanica* (R. Sant.) Awas. are reported for the first time from Papua New Guinea. The morphological and chemical variation of the Himalayan species *Hypogymnia delavayi* (Hue) Rassad. is discussed. An updated key to the Australasian species is given.

Introduction

In the 1979 revision of the lichen genus *Hypogymnia* in Australasia (Elix 1979) a total of eleven species and five varieties was accepted for the region. In the intervening decade many more collections of *Hypogymnia* from Australasia and throughout the world have been examined and a further two new species are described here, one from the Australian mainland and one from Tasmania. In addition, three further species are reported for the first time from the region and an updated key to the Australasian species is given.

Throughout the present work chemical constituents were identified by thin layer chromatography (Elix, Johnston & Parker 1987, 1988), high performance liquid chromatography (Lumbsch & Elix 1985) and by comparison with authentic samples.

Hypogymnia australica Elix sp. nov. Figure 1

Species cum thallo ut in *Hypogymnia enteromorphoides* sed ab hac specie parviore, lobis angustioribus, apotheciis dispersis, subtus eperforatis et acidum physodalicum et acidum protocetraricum deficiente differt.
Type. Australia. New South Wales. On *Leptospermum*, Great Dividing Range, 12.6 km east of Bungendore, 850 m, *J. A. Elix 2992*, 23.iii.1977; CBG-holotype.

Thallus foliose, corticolous, loosely adnate, pale grey to grey, to 7 cm in diameter. *Lobes* subcontiguous centrally, becoming linear-elongate, di- or trichotomously branched and lacking lateral contacts marginally, 1.0-2.5(-3.0) mm wide, evenly inflated and hollow throughout. *Upper surface* convex to ± flattened in older lobes, smooth, shiny, rarely black-margined, lacking isidia and soredia; medulla white within but blackened adjacent to the lobe cavity. *Lower surface* black, pale brown at the apices, strongly wrinkled, lacking perforations in the lower cortex. *Apothecia* common,

scattered, 1-5 mm in diameter, sessile to short-pedicellate, swollen basally when young; disc red-brown to dark brown, ± shiny, concave at first then undulate-distorted, margin involute at first, but becoming crenate; asci 8-spored, spores simple, colourless, ellipsoid, 5-8 x 3.5-4.5 µm. *Pycnidia* common, subspherical, immersed, black; conidia bifusiform, 5-6 x 1 µm.
Chemistry. Cortex K+ yellow; medulla K-, C-, KC+ rose, P- ; containing atranorin, chloroatranorin, physodic acid (major), oxyphysodic acid (minor), 2'-*O*-methylphysodic acid (minor) and alectoronic acid (trace).

This new species appears to be related to *Hypogymnia enteromorphoides* Elix as both species have similar inflated, extended, discrete marginal lobes and basally inflated apothecia. However these species differ chemically and in overall growth habit, thallus morphology and distribution of the apothecia. Thus the thallus of *H. australica* is smaller (5-7 cm) than that of *H. enteromorphoides* (8-15 cm), the lobes are narrower (1.0-3.0 cf. 3.0-7.0 mm wide) and more deeply divided, and the primary lobes are subcontiguous. The primary lobes are contiguous in *H. enteromorphoides*. *H. australica* also differs in lacking perforations in the lower cortex and having scattered apothecia. By contrast *H. enteromorphoides* commonly has perforations in the lower cortex and grouped apothecia.

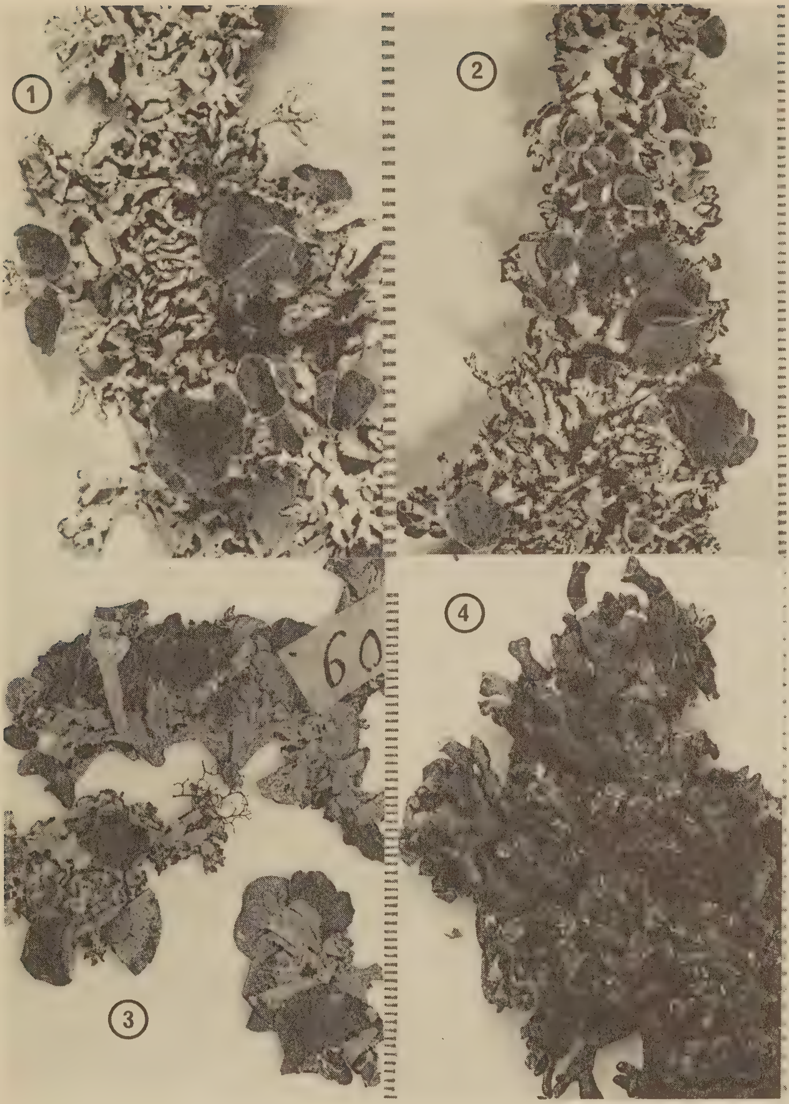
These species also differ chemically. The large majority of specimens of *H. enteromorphoides* react P+ and contain physodalic acid and protocetraric acid in addition to the physodic acid complex, while *H. australica* always reacts P- and contains only the physodic acid complex. These two species are very rarely sympatric : *H. australica* generally occurs east of the Great Dividing Range in central New South Wales; while *H. enteromorphoides* has a more extensive and southerly distribution in New South Wales (particularly the Snowy Mountains), Victoria and Tasmania.

Specimens Examined.
NEW SOUTH WALES. On *Eucalyptus* twigs, type locality, *J. A. Elix 2985*, 23.iii.1977 (MEL); on twigs of *Banksia*, *Hakea* and *Lambertia* shrubs, Peckmans Plateau, Katoomba, 980 m, *J. A. Elix 3199, 3202, 3620*, 24.iv.1977 (ANUC); on *Bursaria spinosa* twigs, along Reedy Creek, Marble Arch, 48 km south of Braidwood, 620 m, *J. A. Elix 4437*, 2.iii.1978 (ANUC); on *Leptospermum* shrubs in dry sclerophyll forest, north-east slopes of Mt. Canobolas, near Orange, 1320 m, *J. A. Elix 4625*, 1.iv.1978 (ANUC).

Hypogymnia tasmanica Elix sp. nov. Figure 2

Species cum thallo ut in *Hypogymnia turgidula* sed ab hac specie majore, lobis nigromarginatis et medulla nigricante differt.
Type. Australia. Tasmania. On *Banksia* in open woodland, along shore of Lake St. Clair, *J. A. Elix 5643*, 18.i.1979; CBG-holotype; MEL-isotype.

Thallus foliose, corticolous, loosely adnate, grey or grey with black margins, lines or patches, orbicular to 8 cm in diameter or irregularly spreading. *Lobes* contiguous to subcontiguous centrally or throughout the thallus, occasionally developing marginal linear, di- or trichotomously branched lobes which lack lateral contacts, 2.0-4.5 mm wide, evenly inflated and hollow throughout. *Upper surface* convex to ± flattened in older lobes, smooth, shiny, commonly black-margined, lacking isidia and soredia; medulla blackened adjacent to the lobe cavity. *Lower surface* black, pale brown at the apices, strongly wrinkled, eperforate. *Apothecia* common, scattered, 1-7 mm in diameter, short-pedicellate, not swollen basally; disc red-brown to dark brown, ± shiny, concave at first then undulate-distorted, margin entire, thin; asci 8-spored, spores simple, colourless, ellipsoid, 7-9 x 4.5-5.5 µm. *Pycnidia* common, subspherical,



Figures 1-4. Species of *Hypogymnia*. 1, *H. australica* (holotype in CBG); 2, *H. tasmanica* (holotype in CBG); 3, *H. delavayi* (holotype in PC); 4, *H. delavayi (Poelt N86-L698* in GZU). Scale in mm.

immersed, black; conidia bifusiform, 5.5-6.5 x 0.7 µm.
Chemistry. Cortex K+ yellow; medulla K-, C-, KC+ rose, P- ; containing atranorin, chloroatranorin, physodic acid (major), oxyphysodic acid (minor) and alectoronic acid (trace).

This new species is related to *Hypogymnia turgidula* (Bitter) Elix as both are corticolous in subalpine areas, have comparable thalli with inflated, contiguous lobes and short-pedicellate apothecia which are not swollen basally, plus identical medullary chemistry (physodic acid complex). *H. tasmanica* differs in developing black lines, bands or patches on the upper surface and by the medulla surrounding the lobe cavity being completely blackened. *H. turgidula* normally has a grey upper surface and a relatively thick, white medulla - the medulla adjacent to the lower surface becomes discoloured (brown) only rarely but never completely blackens. These two species are rarely sympatric in Tasmania. Whereas *H. turgidula* also occurs in New Zealand (common) and New South Wales (rare), *H. tasmanica* appears to be restricted to Tasmania.

Specimens Examined.
TASMANIA. On *Cassinia* sp., Nelson River, central Tasmania, 42°06'S, 145°43'E, 320 m, *G. C. Bratt 72/176*, 3.iv.1972 (HO); on dead wood, Tinder Box road, south-east Tasmania, 43°02'S, 147°18'E, 5 m, *G. C. Bratt & J. A. Cashin 3544,* 2.x.1966 (HO); on limbs of tree, Lake St. Clair, 760 m, 42°06'S, 145°43'E, 320 m, *D. Cannel (G.C. Bratt 70/587),* 1970 (HO); on upper twigs of *Phyllocladus asplenifolius* in rainforest, Little Denison River Forestry Concession, 420 m, *G. Kantvilas 92/80*, 17.iv.1980 (ANUC); on *Nothofagus cunninghamii* in rainforest, 5-road, Florentine Valley, near Maydena, 450 m, *G. Kantvilas 269/80*, 12.vii.1980 (ANUC); on *Drimys lanceolata* in rainforest, Telopea road near Ben Nevis, south-east of Launceston, 870 m, *G. Kantvilas 559/80*, 5.xi.1980 (ANUC); on *Nothofagus cunninghamii* in rainforest, Sumac road, spur 2 - South Arthurs River Forestry area, 170 m, *G. Kantvilas 658/80*, 24.xi.1980, *G. Kantvilas 315/81*, 14.v.1981 (ANUC); on *Nothofagus cunninghamii* in rainforest, Savage River Pipeline road, south of Rapid River, 480 m, *G. Kantvilas 723/80*, 27.xi.1980 (ANUC); on *Adenopetalum biglandulosum* in rainforest, Mt. Mangana, South Bruny Island, *B. Muffet 3323/44*, 25.i.1977 (ANUC).

New Combination

Hypogymnia pectinatula (Zahlbr.) Elix, comb. nov.

Basionym: *Parmelia pectinatula* Zahlbr., *Annls. Cryptog. Exot.*, **1**, 208 (1928).
Holotype: Java, in montis Pangerango regione alpina, alt. 2985 m, leg. V. Schiffner, Iter Indicum 1893/1894, No. 3002, 9.v.1894 (W).

Specimens now assigned to this species previously were considered to be esorediate forms of *H. vittata*. However following field studies in Papua New Guinea this appeared highly unlikely. In particularly favourable sites, four morphologically similar but distinct, lobulate species could be distinguished: *H. vittata* (with terminal labriform soralia), *H. pseudobitteriana* (with laminal, pustulate soralia), *H. zeylanica* (with isidia) and *H. pectinatula* (no isidia or soredia).
Specimen Examined.
PAPUA NEW GUINEA. On a tussock in subalpine grassland with scattered shrubs, Mt. Giluwe, 4 km south-east of summit, Southern Highlands, 3650 m, *H. Streimann 24266*, 12.ix.1982 (CBG, LAE).

New Records

Hypogymnia pseudobitteriana (Awas.) Awas.
This species has been reported previously from India and the Philippines.
Specimens Examined.
PAPUA NEW GUINEA. On dead stump along border of montane forest, Onim Forestry Station, Iaro River, 14 km north-north-west of Ialibu, 6°09'S, 143°57'E, 2280 m, *J. A. Elix 13406 & H. Streimann*, 19.xii.1982 (ANUC); on trunk of *Lithocarpus* in well lit situation in forest, Mt. Gahavisuki near Goroka, Eastern Highlands, Grid ref. CP 23, 2200 m, *P. W. Lambley 644*, 8.vi.1986 (ANUC, UPNG); on tree trunk, *Nothofagus* - Podocarpaceae dominated ridge, Spreader Divide, 12 km north-west of Aseki, Morobe Province, 7°16'S, 146°06'E, 2000 m, *H. Streimann 11858 & E. Tamba*, 21.i.1981 (CBG, ANUC).

Hypogymnia zeylanica (R. Sant.) Awas. & Singh
This species has been reported previously from Sri Lanka and India.
Specimens Examined.
PAPUA NEW GUINEA. On *Podocarpus* in ridgetop forest, near Myola, Central Province, Grid ref. EK 8690, 2750 m, *P. W. Lambley 97/85*, 23.iv.1985 (ANUC, UPNG).

Notes

Hypogymnia delavayi (Hue) Rassad. Figures 3,4
in *Bot. Mater. Gerb. Bot. Inst. V.A. Komarova* **11**, 5 (1956).

Basionym: *Parmelia delavayi* Hue, in *Bull. Soc. Bot. Fr.* **60**, 21 (1887).
Lectotype: China, Yunnan. Au col de Hoang le in Keou prés le Capin-tze, 1800 m alt. Leg. *Abbé Delavay no. 1609*, 11.iii.1885 (PC!).

Previously this species has been poorly understood because of the broad range of morphotypes and chemotypes that it exhibits. It appears to fill the same ecological niches in the high Himalayas that *H. lugubris* (Pers.) Krog does in the alpine areas of the Southern Hemisphere (New Zealand, Tasmania and South America), and is probably related to that species. A full description of this species follows.

Thallus foliose, corticolous, saxicolous or terricolous, loosely adnate, pale grey or more commonly black-grey or completely blackened, orbicular to 8 cm in diameter or with irregularly spreading lobes. *Lobes* generally free, lacking lateral contacts or more rarely compacted and imbricate, linear, dichotomously to irregularly branched, 0.5-2.5 mm wide, evenly inflated and hollow throughout. *Upper surface* convex to ± flattened in older lobes, smooth, becoming blackened throughout and not sharply delimited from the lower cortex, lacking isidia and soredia; medulla white within but discoloured or blackened adjacent to the lobe cavity in the lower half of the lobes (rarely becoming completely blackened adjacent to the cavity). *Lower surface* black, strongly wrinkled, commonly with relatively large apical perforations. *Apothecia* very rare, 2-7 mm in diameter, sessile to short-pedicellate, base not swollen; disc brown, ± shiny, concave at first then funnel-shaped, margin entire at first but becoming crenate, the amphithecium deeply and distinctly wrinkled; asci 8-spored, spores simple, colourless, ellipsoid, 6-8 x 4-5 µm. *Pycnidia* common, subspherical, immersed, black; conidia weakly bifusiform, 4-6 x 1 µm.
Chemistry. Cortex K+ yellow; medulla K-, C-, KC+ rose, P- or P+ red ; containing atranorin, chloroatranorin, physodic acid (major), oxyphysodic acid (minor), 2'-*O*-methylphysodic acid (trace), alectoronic acid (trace), ± physodalic acid (major), ± protocetraric acid (minor).

Although this species resembles *H. lugubris* in many respects - substrate, growth habit, ecology, the rarity of apothecia, the separate, ± vagrant lobes, chemistry - it differs in having frequent perforations in the lower surface of the lobes and in lacking black lines, bands or patches on the upper surface. Instead the whole upper surface blackens (Figure 4). It seems highly likely that it was *H. delavayi* that Nuno referred to as *H. lugubris* v. *sikkimensis* (Nuno, 1964).

H. delavayi occurs on branches and twigs but more commonly on rocks and soil. The thallus is commonly blackened throughout, although occasional specimens (e.g. the lectotype, Figure 3) have a pale yellow-grey upper surface. The P+ chemotype (containing physodalic acid and the physodic acid complex) is more common than the P- chemotype (containing the physodic acid complex only). However these two chemotypes intergrade : physodalic acid may be absent, present in minor or trace quantities or even the major secondary metabolite present. Previously this species has been recorded only from Yunnan (China) and Nepal.

Specimens Examined.
NEPAL. On rocks, Khumbu Himal, near Ngozumpa Glaciers, mountains north of Chhugyuma, 5200-5600 m, *W. Brandstetter*, iv.1977 (GZU); on soil, Tsona, Langtang area, 4050 m, *G. & S. Miehe 3659c*, 18.vi.1986 (GZU); on soil, Jikeapsa, north-east of Kyangjin, 4450 m, Langtang area, *G. & S. Miehe 4352* (GZU); on soil and debris, Yala, Langtang area, 4960-5120 m, *G. & S. Miehe 4642*, *4680c*, 3.vii.1986, *G. & S. Miehe 5290*, *5297*, 12.vii.1986 (GZU); on *Rhododendron* twigs, Ganja-La, Langtang area, 4800 m, *G. & S. Miehe 6202b*, 23.vii.1986 (GZU); on soil, Surdscha Kunda, Langtang area, 4850 m, *G. & S. Miehe 8728*, *8738b*, *8766*, *8886a*, 11-13.viii.1986 (GZU); on branch of shrubs, Langshisa Glacier, Langtang area, 4090 m, *G. & S. Miehe 11725a*, 15.ix.1986 (GZU); on SW exposed rock ledges, lateral moraines, Langshisa Glacier, Langtang area, 4530 m, *G. & S. Miehe 11835*, *12017*, *12022a*, 16.ix.1986 (GZU); on soil, terminal moraine of Langtang Glacier, 4990 m, *G. & S. Miehe 12407*, 20.ix.1986 (GZU); on soil, Karka Sawa, Langtang area, 4990 m, *G. & S. Miehe 12543*, 22.ix.1986 (GZU); on soil, Upper Langtang, west lateral moraine, Langtang area, 4880 m, *G. & S. Miehe 12834*, 26.ix.1986 (GZU); on juniper twigs, Pemdang Karpo, Langtang area, 4620 m, *G. & S. Miehe 13056b, 13056e*, 29.ix.1986 (GZU); on soil, above Pemdang Karpo, Langtang area, 5270 m, *G. & S. Miehe 13324*, 3.x.1986 (GZU); on soil in *Rhododendron* dwarf scrub, terminal moraine, Pemdang Karpo, Langtang area, 4660-5000 m, *G. & S. Miehe 13448*, 5.x.1986, *G. & S. Miehe 13602*, 7.x.1986 (GZU); on juniper branches in *Juniperus* 'Krummholz', Langshisa Glacier, S-flank, Langtang area, 4400 m, *G. & S. Miehe 13846*, 9.x.1986 (GZU); on juniper branches, Niang Tsoha, Langtang area, 4820 m, *G. & S. Miehe 14002*, 12.x.1986 (GZU); on huge rocks near Kyangjin, 3750 m, Langtang area, *J. Poelt N86-L248*, *N86-L258*, 8-10.ix.1987 (GZU); on soil, slopes north of Kyangjin, moraines of Langtang Lirung Glacier, Langtang area, *J. Poelt N86-L771*, 9.ix.1987 (GZU); on big rocks west of Kyangjin, north of Langtang Khola, Langtang area, 3750 m, *J. Poelt N86-L698*, 10.ix.1987 (GZU); over mosses, big rocks in low scrub, Langshisa, Langtang area, c. 4150 m, *J. Poelt N86-L667*, 15.ix.1987 (GZU); on soil, north exposed slopes above Langshisa Kharka and moraines of Shalbachun Glacier, Langtang area, c. 4400 m, *J. Poelt N86-L478*, 16.ix.1987 (GZU); on soil, north exposed slopes towards Langshisa Glacier, south-east of Langshisa Kharka, Langtang area, c. 4300 m, *J. Poelt N86-L303*, *N86-L7358*, 17.ix.1987 (GZU).

KEY TO THE SPECIES OF *HYPOGYMNIA* IN AUSTRALASIA

1. Thallus sorediate or isidiate..2
1. Thallus lacking soredia and isidia..7

2. Thallus isidiate .... *H. zeylanica*
2. Thallus sorediate...3

3. Medulla mainly solid.. *H. pulverata*
3. Medulla hollow for the most part..4

4. Lobes with conspicuous and regular lobulae 5
4. Lobes lacking conspicuous lobulae 6

5. Soralia terminal, labriform.. *H. vittata*
5. Soralia laminal, subpustulate...................................... *H. pseudobitteriana*

6. Lobes crowded, subcontiguous................. *H. subphysodes* v. *austerodioides*
6. Lobes elongated, lacking lateral contact.......... *H. subphysodes* v. *subphysodes*

7. Medulla solid...8
7. Medulla hollow 10

8. Lobes mainly contiguous .... *H. billardieri*
8. Lobes mainly separate..9

9. Thallus corticolous, lobes flattened, medulla P-......................... *H. mundata*
9. Thallus saxicolous, lobes subterete, medulla P+........................ *H. tubularis*

10. Lobes contiguous throughout..11
10. Marginal lobes separate, without extensive lateral contacts.........................13

11. Thallus saxicolous, blackened..................................... *H. kosciuskoensis*
11. Thallus corticolous, grey...12

12. Apothecia basally swollen, lobes 3-6 mm wide.................... *H. pulchrilobata*
12. Apothecia not basally swollen, lobes 1-3 mm wide..................... *H. turgidula*

13. Central lobes contiguous to subcontiguous...14
13. Central lobes lacking lateral contacts...17

14. Apothecia basally swollen, lobes 2-5 mm wide 15
14. Apothecia not basally swollen, lobes 1-3 mm wide...................................16

15. Lobes 2-3 mm wide, medulla P-.. *H.australica*
15. Lobes 3-5 mm wide, medulla P+ .... *H. enteromorphoides*

16. Medulla adjacent to cavity completely blackened....................... *H. tasmanica*
16. Medulla adjacent to cavity white or discoloured below................ *H. turgidula*

17. Lobes markedly lobulate.. *H. pectinatula*
17. Lobes elobulate...18

18. Thallus cartilaginous, medulla thick, ± solid........................... *H. tubularis*
18. Thallus brittle, medullary layer thin..19

19. Lobes sparsely branched, markedly elongate............... *H. lugubris* v. *lugubris*
19. Lobes moderately to densely branched, short...20

20. Lobes irregular, crowded, markedly imbricate, with sparse black
markings and brown apices............................... *H. lugubris* v. *compactior*
20. Lobes loosely dichotomously branched, not imbricate and with
prominent black markings............................... *H. lugubris* v. *sublugubris*

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NORTHERN FRUITING OF *PISOLITHUS TINCTORIUS* (GASTEROMYCETES, SCLERODERMATALES)

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Pisolithus tinctorius (Pers.) Coker and Couch (Gasteromycetes, Sclerodermatales) is an ectomycorrhizal fungus which has received much attention in recent years due to its applications in forestry (Marx 1984). This fungus is found world-wide and forms ectomycorrhizae with a broad range of hosts, including most commercially important conifer and hardwood trees (Marx 1977).

Extensive reports on the distribution of *P. tinctorius* have appeared in the literature. Its world distribution was reviewed by Marx in 1977, and its distribution in the United States was reviewed by Grand in 1976. This species is considered to have a Mediterranean and warm-temperate distribution (Grand 1976, Marx 1977, Ing 1985).

Marx (1977) reports *P. tinctorius* as occurring in 38 states of the United States, with a predominantly central, southern and western range; one Michigan collection is cited. Grand (1976) reports *P. tinctorius* as occurring as far north as Washington (approx. 48°00'N) in the western United States, but in mid-continent only as far north as central Michigan (approx. 43°30'N). The northern-most collection of *P. tinctorius* in the University of Michigan herbarium is also from the central part of the state (Edgewood, Gratiot County), which coincides with the locality reported by Grand (1976).

In Canada, *P. tinctorius* has been reported as far north as Ontario's Sudbury District (46°40'N), on mine tailings, and from the Muskoka District (45°00'N) in an undisturbed forest (Malloch and Kuja 1979). *Pisolithus tinctorius* was reported for the first time from Ireland (Tipperary, 52°30'N) in 1984; the collector of which stating, "exceptional weather of the summer of 1984" was probably responsible for it fruiting there (Ing 1985).

Smith (1951) considered *P. tinctorius* rare in the Great Lakes region. Alan Parker (pers. comm.), collecting in northern Wisconsin (Eagle River, Vilas County, 46°10'N), found three specimens of *P. tinctorius* there in 1987. Though the author of the present paper has been collecting ectomycorrhizal gasteromycetes in the Upper

Peninsula of Michigan for the past five years, *P. tinctorius* has not been found prior to 1988, when five collections were made.

Table 1 lists the collections of *P. tinctorius* made in the Upper Peninsula of Michigan (from 46°05'N to 47°09'N) following the extremely hot, dry summer of 1988. Two collections were of single fruiting bodies, and one collection was of two fruiting bodies; more were not found at these sites even though an extensive search was conducted. These small collections were associated with mature *Quercus rubra* L.; mature *Pinus resinosa* Ait. were also present at one site. The other two collections were of numerous fruiting bodies, and were associated with *Betula papyrifera* Marsh. on mine spoils. Here, the barren, rocky sites were being colonized by clusters of young trees, estimated at from 5-20 yrs in age.

The hot, dry weather of 1988 resulted in severe drought in the Upper Peninsula of Michigan. Data from the National Weather Station at Houghton, Michigan (47°07'N) show that the mean daily temperature from April through September was from 1 to 3 degrees C above normal; April through July was drier than normal as well, receiving 1.68 to 5.38 cm less monthly rainfall (Anonymous 1988).

Table 1. Collections of Pisolithus tinctorius from the Upper Peninsula of Michigan in 1988.

Date	Location	Habitat	Associated Hosts	Notes
7 Sept.	Dollar Bay, Houghton Co. (47°08'N)	gravel roadside	Quercus rubra L.	single, unopened fruiting body 7 X 5 cm
9 Sept.	Houghton, Houghton Co. (47°07'N)	mine spoils	Quercus rubra L.	single, unopened fruiting body 6 X 4 cm
10 Sept.	Iron River, Iron Co. (46°05'N)	mine spoils	Betula papyrifera Marsh.	prolific fruiting, all stages, 2-8 X 2-10 cm
15 Sept.	Mason, Houghton Co. (47°09'N)	mine spoils	Betula papyrifera Marsh.	prolific fruiting, all stages, 2-8 X 2-10 cm
30 Sept.	Marquette, Marquette Co. (46°30'N)	sandy, lawn edge	Quercus rubra L. and Pinus resinosa Ait.	two fruiting bodies, one mature, 7 X 6 cm, one unopened 7 X 5 cm

The northern-most fruitings of *P. tinctorius* reported by Grand (1976) in the middle and eastern United States generally follow and lie below the 21.1 C (70 F) isotherm for July average daily temperatures (Anonymous 1983). The average daily temperature for July in Houghton, Michigan in 1988 was 21.6 C (Anonymous 1988). This is 2.9 degrees above normal and 0.5 degrees above the isotherm where *P. tinctorius* has previously been reported. Thus, conditions here were comparable to those where *P. tinctorius* normally fruits.

In physiological studies, Marx *et al*. (1970) found that mycelial growth of *P. tinctorius* was greatest at the relatively high temperature of 28 C, and that ectomycorrhizal development with *Pinus taeda* L. was greatest at 34 C. Furthermore, Marx (1977) found *P. tinctorius* more abundant in soils with high surface temperatures. In the Upper Peninsula of Michigan during the summer of 1988, higher than normal air temperatures, combined with lower than normal rainfall, probably resulted in higher than normal soil temperatures. These factors may contribute to the fruiting of ectomycorrhizal fungi with physiological characteristics like those of *P. tinctorius*.

Also studying the effects of growth temperature on ectomycorrhizal fungi, Cline *et al*. (1987) similarly found that *P. tinctorius* exhibited the greatest growth at the higher temperature treatments. In that study, *P. tinctorius* was the only fungus of four tested which demonstrated a relationship between growth performance and geographic origin. This suggests that *P. tinctorius* may be more sensitive to temperature than other ectomycorrhizal fungi. Northern isolates of *P. tinctorius* may be better suited for use in ectomycorrhizal inoculation of tree seedlings in regions where cooler conditions prevail.

Pure cultures of these five northern collections of *P. tinctorius* were obtained from fresh sporocarp tissue. This provides the opportunity to study their growth rates at various temperatures, and to compare them with isolates from more southerly locations. These studies, and those involving their effectiveness at forming ectomycorrhizae with hosts important to the forest industry in the northern Lake States, would be valuable research to conduct with these isolates.

That *P. tinctorius* was found fruiting in the Upper Peninsula of Michigan, north of where it normally fruits, has interesting implications for researchers isolating the fungus symbionts from ectomycorrhizae. It is unlikely that *P. tinctorius* colonized root systems of its hosts and fruited here all in a single season. It is more likely that this fungus was present as a root symbiont in previous years, but did not fruit here until weather conditions became favorable. If this is the case, then one could conceivably isolate ectomycorrhizal fungi from host root systems in regions beyond where they are known to occur from fruiting records.

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BOOK REVIEWS

by
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AGARIC FLORA OF SRI LANKA, by David N.PEGLER, , 519 pp., 104 fig., 125 x 24 cm, paperback, Kew Bulletin Additional Series XII, 1986. Her Majesty's Stationery Office, Room 2C03, St. Crispins, Duke Street, Norwich NR3 1PD, UK. ISBN 0 11 250004 8. £27.-

Virgin forests in tropical countries are subject to annihilation at such a dramatic speed, that tropical mycological flora can be said endangered. Organized extensive mycological explorations are urgently needed. Sri Lanka is one of these countries. Fortunately, collecting the agaricoid flora of Sri Lanka started more than 140 years ago. Gardner (1844) sent 1200 specimens, with water-colour illustrations, to Berkeley who described 305 of them as new species. Later, Thwaites's (1868-9) collections were published by Berkeley and Broome. After Beccari, Cesati and von Höhnel, Petch (1905-25) added a lot more, revised Berkeley & Broome's species, and described 79 others. Pegler himself visited the county in 1974.

The *Agaric Flora of Sri Lanka* is the third of a series of tropical fungus floras by Pegler, after East Africa, 1977 and Lesser Antilles, 1983. It covers 335 accepted species within 94 genera and 21 families. With the same consistent method, care and precision, the author has carried out his study mainly on type and authentic material preserved at Kew Herbarium.from Berkeley, Berkeley and Broome, and Petch. This flora is therefore also a taxonomic revision according to modern taxonomy, proposing more than 70 new combinations and 4 new names, but only one new species. Agaricoid taxa are described in Aphyllophorales, Cantharellales, Boletales, as well as in the Agaricales and Russulales. For all taxa a complete revised synonymy, an accurate description based on exsiccata, and some comments are provided. Most descriptions are illustrated by some line drawings of spores, cystidia, epicuticular elements or pileal hairs, and very fine habit sketches drawn from the available copies of the original water-colour paintings.

Such outstanding revision of today's knowledge of the tropical agaricoid flora of Sri Lanka is most welcome, as a new basis for further collecting and research in that country as well as in any other tropical area.

AN ANNOTATED CATALOG OF THE PYRENOMYCETES DESCRIBED BY CHARLES H. PECK, by Margaret E. BARR, Clark T. ROGERSON, Stanley J. SMITH and John H. HAINES, New York State Museum Bull. 459, 74 pp., 21 x 28 cm, Paperback, 1986. The University of the State of New York, The State Education Dept., Albany, N.Y. 12234, U.S.A. ISBN 1-55557-005-4.

Charles Horton Peck, botanist at the New York State Museum, at Albany, from 1867 to 1915, described a huge number of new species of fungi, but including

Ascomycetes in the years 1870-1888. One hundred of them were described with M.C. Cooke between 1871 and 1876.All specimens, including types, from Peck's herbarium, are preserved at the herbarium NYS.

The purpose of the catalog is to provide a comprehensive and updated listing of Peck's Ascomycetes classically termed Pyrenomycetes, including both euascomycetes and loculoascomycetes. Most of the type specimens were reexamined, to ascertain a revised position of the taxa where necessary. Entries are specific epithets in alphabetical order, followed by its original generic position and the correct citation Data on type specimens include the host and other collection data, and reference to duplicates either sent to Cooke (K) or deposited in NY or BPI herbarium. Currently accepted taxonomic positions of the taxa, with synonymies, are given and 23 new combinations are proposed, with full arguments, supported by illustrations. Such a paper provides a greatly needed tool that anyone ought to have when consulting old mycological literature. Similar research work is to be encouraged.

CHAMPIGNONS DU TONKIN, illustrations of fungi in the Farlow Reference Library with the mycological papers of N.T. PATOUILLARD, by Donald H. PFISTER, 20 pp., 132 fig. in 3 colour microfiches, 4 text microfiches, cloth hardcover, 22 x 28 cm, 1985. Meckler Publishing and Chadwyck-Healey Ltd, 11 Ferry Lane West, Westport, CT 06880, USA. ISBN 0-930466-95-0. US$145.00.

Many mycological thesauri are probably still hidden in botanical Museums that deserve publication. Patouillard's collection was one that Pfister revealed to the public. This publication includes the reproduction of 26 Patouillard's papers published from 1890 to 1928 on fungi collected by V. Demange in North Viet-Nam (Tonkin and Annam), Laos and Cambodia, and the colour reproduction on archival quality silver halide film of 172 plates of water-colour paintings of those fungi. Pfister, who is the author of "An annotated index to fungi described by N. Patouillard" (1977), introduces the publication with a short historical account about Patouillard, Demange, and other fungus collectors in South East Asia, and produces a list of the colour illustrations, with original taxonomic names and references to Patouillard's Herbarium and publications. A selected bibliography on fungi in Viet-Nam and adjacent areas is added.

ICONES MYCOLOGICAE, Tome V. Liste préliminaire et Explication des Planches, by Emile BOUDIER, with contributions by J. VAN BRUMMELEN, *Introduction,* R.P. KORF, H. CLEMENÇON, W. JÜLICH and V. DEMOULIN, *Revision des espèces,* XXX + 300 pp., 24 x 32 cm, leather hardcover, 1985. Editions Piantanida, Lausanne, Switzerland.

The fifth volume of the reprinted edition of Boudier's "Icones Mycologicae" reproduces in facsimile the original lists of the species illustrated in the plates and the explanation to each of them, in 6 series of one hundred at a time. The introduction to that re-edition consists of a historical account on Boudier and his work, as well as a table recording the distribution dates of the 30 successives sets of plates. The revision of the species, in charge of R.P. Korf, has been shared by H. Clemençon for the Agaricales, Russulales and Boletales (plates 1-82, 84-150), W. Jülich for the Aphyllophorales (83, 151-181), V. Demoulin for the Hymenogastrales (184-193), and R.P. Korf himself for the Ascomycotina, mostly Discomycetes and a few Pyrenomycetes, some Deuteromycotina and one Myxomycota (194-600). The revision provides, when possible, the currently valid name for each taxon illustrated by Boudier according the numerical order of the plates, with, in addition, diverse comments, taxonomic justifications, and bibliography. The names as revised, but not all those that are proposed by H. Clemençon, are in agreement with the Sydney International Code of Botanical Nomenclature. In the Ascomycetes, and particularly in the Discomycetes — the special field of Boudier and of Korf, Korf has taken much care in providing, beside the correct valid name in agreement with his taxonomic opinion, any other nomenclatural or taxonomic synonyms that in the opinion of other taxonomists might be alternate correct names. This open way of stating the present nomenclatural or taxonomic status of Boudier's taxa is intended to be useful to most and to enhance further investigations. An index of both original and revised names of the taxa ends the volume.

The reprinting of Boudier's "Icones Mycologicae" has been a difficult enterprise, initiated by R. Karger of the Société Mycologique de Chalon-sur-Saone, France, and successfully brought to the excellent final product that all subscribers have greatly appreciated. But what has made that reprint most accessible and useful to mycologists is that updating of Boudier's taxonomy by Korf and others as presented in this volume. Not only looking with admiration at the Boudier's colorful plates, but using them for scientific purposes is possible now, with great enjoyment.

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*On p. 262, lines 30-32 should read:

A≠B≠: Clamp connections at most septa.
A≠B=: False clamps at most septa.
A=B≠, or A=B=: Simple septa throughout.

*On p. 273, to be inserted under *Lactarius*:

L. manzanitae Methven, Mycologia 77: 475. 1985. CALIFORNIA. Mendocino Co.: Jackson State Forest, under *Arctostaphylos*, 21 Nov 1982, *Desjardin 1775*.

L. riparius Methven, Mycologia 77: 476. 1985. CALIFORNIA. El Dorado Co.: Audrian Lake, under *Abies*, *Alnus*, and *Salix*, 3 Oct 1982, *Methven 1715*.

L. scrobiculatus var. *montanus* Methven, Mycologia 77: 478. 1985. CALIFORNIA. El Dorado Co.: Audrian Lake, under *Abies* and *Pinus*, 3 Oct 1982, *Methven 1716*.

*On p. 273, to be inserted under *Leccinum*:

L. arbuticola Thiers, Calif. Mushrooms: A field guide to the boletes, 126. 1975. CALIFORNIA. Nevada Co.: near Nevada City, scattered to gregarious under madrone, 11 Nov 1972, *Thiers 30514*.

*On p. 276, to be inserted between lines 27 and 28:

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